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Regional Conference of Elected Officials
Penjerdel Region

1968

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GOVERNMENTAL ORGANIZATION FOR AN AIR RESOURCE MANAGEMENT AND CONTROL SYSTEM IN THE PENJERDEL REGION

A Research Inquiry in Environmental Control Administration for the Regional Conference of Elected Officals

1968

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UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA

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RCEO
AIR POLLUTION
SURVEY REPORT

GENERAL PREFACE

The atmosphere is, by all odds, man's most vital natural resource. Until quite recently, we lived comfortably with the ambivalent views that (1) the atmosphere can be used freely for the disposal of the airborne waste products of an industrialized society, and (2) that people are, at all times, entitled to air in a form which will enable them to live cleanly, comfortably, and in good health.

With the recognition that we now dump more than 133 million tons of aerial garbage into the U. S. atmosphere each year, and recent grim reminders of possible mass death afforded us by stagnant, heavily polluted atmosphere over our metropolitan areas, that comfort no longer exists. As a society, it seems clear that we are irrevocably committed to the development of new public policy, new organizational and institutional forms, and new technology which will insure a safe, healthy atmosphere.

As unique evidence of that commitment, the Regional Conference of Elected Officials, Inc., (RCEO) has sponsored this study of the air pollution problem in the vast 11-county, tri-state region centered on Philadelphia. Part of the unique commitment to action is reflected in the financing arrangement for the study which involved a grant from the United States Public Health Service and the individual contributions of local units of government throughout the region. Further, this study effort provides new evidence that autonomous local units of government can join together in a cooperative venture to solve a common problem.

The Region, for purposes of this study, encompasses the three metropolitan areas of Philadelphia-Camden, Trenton, and Wilmington, located in Pennsylvania, New Jersey and Delaware respectively. The area extends generally along the Delaware River from Mercer County, New Jersey, in the north to New Castle County, Delaware, in the south. This area, about 4, 545 square miles in extent and with a present population of over 5 million, forms an approximate rectangle 80 by 57 miles in size and oriented with the major axis NE-SW.

Exceeded only by the area centering on New York City, this Philadelphia tri-state region has the most complex governmental structure of any urban area in the United States, consisting of 11 counties and 377 municipalities in parts of three states.

The pattern of urban development and industrial concentrations makes it reasonable to consider the Region a discrete area for investigation of air pollution control problems. The urbanized portion of the Region is, in the main, concentrated along both sides of the Delaware River and rarely extends more than a dozen miles inland. A high percentage of the Region's 9, 000 highly diversified manufacturing establishments are located within this band along the River.

The end objective of the study is to define the requirements for the development of an air resource management and control system appropriate to the solution of the problem in the 11-county tri-state Region, and, specifically, to determine the governmental machinery and arrangements through which such a system can operate effectively. The design of a viable management and control system for air pollution must be based on: (1) knowledge of the technical characteristics and dimensions of the problem in terms of the real and potential impact; (2) careful exploration and definition of major approaches in developing the technical methods and procedures to resolve the problem; and (3) construction of the optimal governmental framework, legal base, and administrative procedures through which the functional resolution of the problem can be implemented.

In keeping with this basic approach, the study was organized into three areas: 1) Emissions Survey, 2) Meteorological Analysis, and 3) Governmental Aspects. A separate component technical Report, each with a separate summary, has been prepared under each of these titles. The Emissions Survey was performed by Environmental Engineering and Science, Drexel Institute of Technology; The Meteorological Analysis was performed by C. W. Thornthwaite Associates Laboratory of Climatology; and the Governmental Aspects were analyzed by the Fels Institute of Local and State Government, University of Pennsylvania. A Report containing a review of study findings and implementation of study proposals accepted by RCEO will be prepared by the RCEO staff under Executive Director Chester A. Kunz, Rear Admiral, U. S. Navy, Retired.

The study operated under the general direction of the RCEO Air Pollution Committee with the Hon. John E. Babiarz, Mayor of Wilmington, Chairman.

The study benefited from the interest and efforts of the Technical Advisory Committee which was formed to provide general guidance and counsel at specific intervals. Committee members, representing the Air Pollution control agencies of the three states and the City of Philadelphia, were: Victor Sussman and Frank Willard, Jr., for Pennsylvania; William Munroe and Martin Sanvito, for New Jersey; John C. Bryson and James T. Wilburn, for Delaware; Arthur Wallach and Larry Himmelstein, for Philadelphia.

It should be noted that the findings, conclusions, and recommendations of the technical reports are the sole responsibility of the respective contractors, and the acceptance of these findings and conclusions along with recommendations for implementation will be the responsibility of RCEO.

The study is indebted to the many public and private officials of governmental agencies, business organizations, and civic groups which have cooperated through their sustained interest and active assistance. The efforts of all these participants can best be rewarded by the adoption of a program to insure a safe, healthy atmosphere for all citizens of the Region.

Regional Conference of Elected Officials

June, 1968

Prefatory Note to this Report

This Report views air pollution as an increasingly serious problem of vital significance to the health and welfare of an industrialized society. Air pollution control is a basic part of a larger conflict between accepted or desired human activities and the environmental destruction caused by such activities. The conflict will not be finally resolved until real and potential environmental destruction is recognized not only as an invariable product of human activity, but also as a constraint which must condition, guide, and control that activity.

The present challenge is to construct the political and governmental administrative instruments through which the planned use and control of environmental resources can be established and progressively developed. This Report is designed to meet that challenge in the 11-county Penjerdel Region. The Report prescribes a governmental response in terms of the machinery and arrangements required to achieve and maintain a safe and healthful atmosphere throughout the Penjerdel Region. The basic recommendation of this study is that a viable interstate agency can be established by solemn agreement by the states of Delaware and New Jersey, and the Commonwealth of Pennsylvania. This agency should be charged with primary responsibility for the development and administration of an air resource management and control system throughout the 11-county Region.

The recommendation should be viewed as a radical solution which is based upon a functional analysis of the air pollution problem: the emissions, the meteorological factors, deficiencies in existing control systems, the impact of airborne pollutants and their control on health and economics, and an examination of control standards and functions.

Section I describes the air pollution problem in the Penjerdel Region and appraises the adequacy of the existing legal base and the present response by the various governmental jurisdictions responsible for meeting the problem. The findings are that the Region's atmosphere is highly polluted and has meteorological features which can intensify pollution levels. The present governmental response was found to be fragmented, deficient and incapable of meeting Regional needs.

Section II examines the state of development of air pollution control technology in relation to public policy for air pollution control. The control technology is rapidly emerging but is still burdened with excessively complex control tools geared more to safeguarding the present pattern of our economic and social activity than to making the substantial improvements needed in the quality of the atmosphere.

Section III provides new and perhaps break-through evidence of the impact of pollutants on human health. The health impact analysis, performed for this study by Dr. Richard J. Hickey, biochemist, and his associates at the University of Pennsylvania, indicates the real and present danger to human life in cumulative exposure to low level concentrations of airborne contaminants. Analyses of the complex man-environment ecological system are required to gain fuller understanding and insight provided by these early findings. More research to further document these findings is clearly required and should be given top priority as a national issue in public health.

Section IV makes clear that management and control of the atmosphere involve consideration of the effects produced on the economy. The problem of pollution control has deep roots affecting our entire economic structure. Economic principles and methodologies are suggested as the basis for developing strategies to achieve proper controls at the lowest total social cost. Cost-benefit analyses, based on the threat to human life described in the health impact research, provide economic justification for appropriate controls. Drs. Azriel Teller and J. R. Norsworthy, both formerly of the University of Illinois and now at Temple University, served as the economic consultants for this study, and prepared this section of the Report.

Section V presents the proposed governmental response to meet the air resource management and control needs in the Penjerdel Region. Use of the 11-county Penjerdel Region as an appropriate interstate air quality control region is recommended and documented. The need for an interstate compact as a means of creating a viable regional agency with broad powers for developing an air resource management and control system is made clear. The findings of a detailed legal base analysis supporting the development of an interstate compact and a critical evaluation of alternative devices, including other types of interstate air pollution compacts, are presented. A proposed Penjerdel Interstate Air Pollution Compact, with annotations, is included in the Appendix. Frank P. Grad, Esq., Associate Director of the Legislative Drafting Research Fund of Columbia University, and his associate John Hack, Esq., performed the legal base analysis and prepared the draft compact.

This Report urges the creation of a regional agency, established by interstate compact, with broad powers in air resource management and control. It is naive to assume, however, that the adoption of a compact and creation of the agency is all that is needed to solve the Region's air pollution problem. In a very real sense, the compact and regional agency provide simply a means through which local, state and Federal governments can implement effectively their commitment to improve the quality of the atmosphere in which we live. What is needed is a broad base of political support and a regional constituency to insure, and even demand, effective operation of the regional mechanism proposed. Sponsorship of this study by the Regional Conference of Elected Officials is the first step in building the essential regional constituency.

Many persons and public officials in air pollution control agencies at local, state and Federal levels of government provided assistance and guidance to this research undertaking. While the contributions of all these individuals are gratefully acknowledged, final responsibility for the findings and recommendations contained in this Report remains with the Government Studies Center.

Government Studies Center

October, 1968

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GOVERNMENTAL ORGANIZATION FOR A REGIONAL AIR RESOURCE MANAGEMENT AND CONTROL SYSTEM

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GOVERNMENTAL ORGANIZATION FOR AN AIR RESOURCES MANAGEMENT AND CONTROL SYSTEM IN THE PENJERDEL REGION

SUMMARY OF MAJOR FINDINGS AND RECOMMENDATIONS

Purpose and Scope of Study

The objective of the governmental component of the Regional Conference of Elected Officials Air Pollution Study is to determine the kinds and distribution of governmental powers, controls, and service functions necessary to achieve and maintain a safe, healthful atmosphere throughout the 11-county Penjerdel Region* now and in the future.

The governmental aspects study was based on a functional analysis of the air pollution problem: the emissions, the meteorological factors, the impact of airborne pollutants and their control on health and economics, and an examination of control standards and functions.

Drexel Institute of Technology conducted the emissions survey to identify the types, sources, distribution, and intensity of pollutants emitted to the Region's atmosphere. Thornthwaite Associates Laboratory of Climatology analyzed weather factors and their effects on the dispersion of pollutants entering or originating in the Region. This governmental aspects study performed by the Government Studies Center of the University of Pennsylvania's Fels Institute of Local and State Government included:

1. review of existing law and programs for controlling air pollution in the Region;
2. examination of control system technology and standards (the state of the art);
3. analysis of the impact of air pollutants on health;

---

* The RCEO study area encompassed the Penjerdel Region and includes the counties of Bucks, Chester, Delaware, Montgomery, and Philadelphia in Pennsylvania; Burlington, Camden, Gloucester, Mercer, and Salem in New Jersey; and New Castle County in Delaware.

4. consideration of the economic effects of abatement strategies; and
5. analysis of legal base requirements and possible alternative governmental devices appropriate to meet the Region's air pollution problem.

Recommendations

A. The basic recommendation of this study is that a special interstate agency be created to assume primary responsibility for the development and administration of an air resource management and control system throughout the 11-county Penjerdel Region. The proposed agency and its legal mandate would be established by an interstate compact enacted by the legislatures of Pennsylvania, New Jersey and Delaware and approved by the Congress.

(Section V-A, D, and E)

B. This proposed governmental response to meet the Region's air pollution problem should be viewed as a radical solution. In the judgment of this study, the radical nature of the recommendation is fully warranted by the research findings. The interstate compact proposed is accurately described as a full delegation by the several states of their responsibility and authority for air resource management and control within this Region. The delegation should be viewed as a basic charter for a new level of government which is supported by both state level authority and local representation, and which is truly regional in nature. The proposed response should not be viewed as a limited interstate agreement in which the three states affirm their willingness to negotiate and collectively administer a cooperative or joint interstate effort through some combination of existing state and local programs.

(Section V-D, and Proposed Compact, Appendix)

C. A proposed Penjerdel Air Pollution Control Compact is included as an Appendix to this Report. This Penjerdel Compact is presented in proper draft form, with annotations, to facilitate review and study by the states and earliest possible enactment. The document follows the general design of the Mid-Atlantic States Compact as the most effective compact document of those evaluated in this study. The Penjerdel Compact also reflects the results of a detailed appraisal of experience with interstate air pollution compacts throughout the nation, and the application of criteria for an effective compact.

(Proposed Compact, Appendix)

D. The powers vested in the proposed Compact Commission by the several states should be generally equivalent to those of the states themselves in the area of air resource management and control. Under the Compact the Commission shall:

- investigate the causes and sources of air pollution, identify air contaminants, and provide for research in air pollution causes and effects;
- develop comprehensive plans and programs to improve and maintain the air quality of the Region;
- establish standards for air quality and requirements for control of emissions to abate and prevent air pollution;
- promote, sponsor and conduct technical, educational and research programs for air pollution control;
- enforce rules and regulations developed under the Compact;
- furnish technical services, advice and consultation to agencies of the signatory states.

In the performance of the above duties, the Commission is granted broad powers including the power to:

- issue orders to enforce its rules and regulations and assess penalties recoverable in any court of competent jurisdiction for each day of violation;
- provide for the organization and administration of a Commission staff, including an Executive Director, and the establishment of a personnel system

and compensation plan based on the merit principle;

- establish a Regional system for monitoring air pollutant concentrations; establish and maintain an emergency alert system to safeguard the quality of the Region's atmosphere;
- grant permits and licenses in accordance with rules and regulations promulgated by the Commission;
- designate sub-regional districts, when and where appropriate;
- undertake research on the relationships between air resource management and control and other ecological factors affecting the total environment of the Region, including solid waste and water pollution. The Commission shall inform the Delaware River Basin Commission (DRBC) of its standards, rules and regulations and shall cooperate with the DRBC and other agencies of the Region which have responsibilities in environmental matters;
- apportion the operating expenses of the Commission equitably among the states party to the Compact.

(Proposed Compact, Articles III and IV, Appendix)

E. The proposed Penjerdel Air Pollution Control Commission would consist of six members: the Governors of the states of Delaware, New Jersey and Pennsylvania, or their designees, and three elected members representative of the 11-county Penjerdel Region. The Commission is designed to be organized as soon as legislation can be adopted, with initial membership limited to the three Governors. After two years, the three additional members, each elected to a term of four years by the people of the counties comprising the portion of each state included in the Compact, would be added to Commission membership. Each member would be entitled to one vote on all matters which come before the Commission. Action would be by majority vote, but only if the majority includes two Governors or their designees. The

Federal government would be represented on the Compact Commission, but without a voting membership.

(Proposed Compact, Article II, Appendix)

Research Findings

A. The various sections of this Report describe the magnitude and full dimensions of the Region's air pollution problem. The single most outstanding characteristic of the problem of clearing the regional atmosphere of the tremendous amounts of contaminants it now contains is that no one of the three states or their local jurisdictions can alone perform the air pollution control task.

In the Delaware Valley at present, the effort to reverse the deterioration in quality of the atmosphere represents a massive gamble with the public health. The gamble is that the separate efforts made by state and local control agencies, whose effectiveness is severely limited by inadequate legal bases, jurisdictional limitations, and compromised organization structures, can collectively safeguard the public health of the Region. It is a gamble in which every citizen of the Region has a stake. Yet, each citizen is at present at least partially disfranchised in making a political response to insure his own safety. None of the states or local jurisdictions can alone take action which will guarantee a safe regional atmosphere.

(Sections I and V)

B. Emissions and meteorological data establish that the Penjerdel Region is among the most polluted metropolitan areas of the United States. According to Drexel Institute of Technology's emission survey, approximately 15,000 tons per day of pollutants are discharged into the Regional atmosphere at a fairly constant rate throughout the year. The relative constancy of emissions and the concentration of emissions in the most highly populated area of the Region establish the potential for serious pollution conditions. The meteorological analysis performed by Thornthwaite

Laboratory of Climatology indicates that only relatively favorable meteorological conditions have thus far prevented more frequent pollution episodes or emergencies in the Region.

(Section I-A)

C. The jurisdictional limitations are basically caused by the mosaic of state and local political boundaries which fragment what is a geographically related and economically interdependent Region drawing upon a common air mass. The present pattern of legal and administrative relationships for air pollution control among the states of the Region, and between the states and their political subdivisions reflects only limited cooperative arrangements and a frequently unclear allocation of responsibilities. The pattern does not and cannot provide a base for an effective response to the Region's air pollution problem.

(Section I-B, and C)

D. Primary authority and responsibility for air resource management and control in the Penjerdel Region are vested in the state governments of Pennsylvania, New Jersey, and Delaware. Local governments may engage in air pollution control activities subject to limitations and guidelines in state law and policy. Outside of Philadelphia and a few other scattered municipalities, there are no viable local government air pollution control programs at present. The Federal Clean Air Act of 1967 establishes a continuing Federal interest and involvement in air pollution control matters in this Region and throughout the nation. The Federal Act provides take-over powers if the states do not provide adequate control programs. Despite recent and planned improvements in Delaware, Pennsylvania, and Philadelphia, legal and organizational barriers continue to militate against the development of effective planning and enforcement programs adequate to meet the air pollution control needs of this Region. The New Jersey law and organizational structure represent a comprehensive program reflecting a stronger commitment to effective enforcement measures.

(Section I-B, and C)

E. The impact of air pollution on human health is dramatically more important than commonly understood or accepted. The health impact analysis of this study clearly indicates the real and present danger to human life in cumulative exposure to low level concentrations of airborne contaminants which are present in this Region's atmosphere at high levels of concentration. Analysis of the complex man-environment ecological system is required to gain fuller understanding and insight.

Multivariate statistical studies have demonstrated significant multiple associations between certain air pollutants jointly, chiefly SO_2 and NO_2, and mortality rates for the following chronic diseases: various forms of cancer, certain cardiovascular diseases, vascular lesions of the central nervous system (stroke), and congenital malformations (birth defects).

The fact that pollutants most probably affect the human organism simultaneously and at low concentration levels has pervasive, perhaps radical, implications for control systems and technology. Our control concepts, systems, and structures are oriented primarily toward alleviation of short-term, acute effects under inversion conditions. Abatement policies and standards designed to prevent short-term watering of the eyes may provide no protection against the long-term inducement of certain chronic diseases including cancer, heart disease, and stroke. More research to further document these findings is clearly required and should be undertaken by the appropriate agencies.

(Section III)

F. Analysis of the state of the air pollution control art reveals that the technology is emerging, but that it is still burdened with cautious and excessively complex control tools geared more to safeguarding the present pattern of our economic and social activity than to substantially improving the quality of the atmosphere to safeguard human health. The technical deficiencies in the present effort to manage and control the quality of the Region's atmosphere are related to: (a) the early stage of development of control technology; (b) the need to reappraise and develop new ambient air and emissions standards and regulations designed to prevent both short-term episodic and long-term cumulative health damage; and (c) the need to employ broad, strategic planning and control measures which reflect and guide the economic development of the Region and which utilize selective abatement procedures designed to achieve a safe, healthful regional atmosphere in the shortest possible time.

(Section II)

G. Analysis of the economic aspects of air pollution control indicates that the problem has deep roots affecting our entire economic structure. Management and control of the atmosphere clearly involve consideration of the effects produced on the economy. Economic theory cannot dictate the value judgment as to the proper level of control. Economic principles can be utilized, however, in developing strategies to achieve proper controls at the lowest total social cost. This is especially true if we are to achieve the great reduction of airborne contaminants required to eliminate the threat to human health. Considerably more data and detailed analysis are required to implement and reflect these basic economic concerns. Cost-benefit analyses, based on the threat to human life described in this Report, provide economic justification and suggest strategies for appropriate control measures.

(Section IV)

H. A stable framework of legal and administrative responsibilities which can be implemented throughout the Region is vital to an effective air resource management and control program. The clear need in the Penjerdel Region is for a unified program administered by a single administrative agency with adequate powers to plan, develop, and effectuate strategic air resource planning and control measures throughout the Region. The only appropriate governmental response to the air pollution problem in the Penjerdel Region is an interstate compact for air resource management and control to be implemented by a strong air pollution control agency created by such a Compact.

(Section V)

SECTION I

THE AIR POLLUTION PROBLEM AND EXISTING GOVERNMENTAL RESPONSE IN THE PENJERDEL REGION

A. Physical Dimensions of the Problem: Summary and Synthesis of the Emissions Survey and Meteorological Analysis.

1. Major Finding of the Emissions Survey

The emissions inventory, conducted by the Drexel Institute of Technology, Environmental Engineering and Science Program found that more than 15,000 tons per average day of six major pollutants - oxides of sulfur, oxides of nitrogen, organic compounds (hydrocarbons), carbon monoxide, particulate matter, and benzopyrene - are emitted into the atmosphere from areas within the eleven counties making up the Penjerdel Region. The distribution of all county emissions shown in Table 1 should clearly indicate that air pollution is not exclusively a Philadelphia problem.

Table 1 below shows approximate total average daily tons of pollutants, excluding benzopyrene, and a comparison of percentages emitted within: (1) Philadelphia; (2) Delaware County; and (3) the remaining nine Penjerdel counties:

Table 1

Total Pollutant Tonnage and Percent Emitted in Philadelphia, Delaware, and All Other Counties

	11 County Total	Philadelphia Total	Delaware County Total	All Other Counties
Sulfur oxides	2,600	33%	17%	50%
Nitrogen oxides	1,000	33%	14%	53%
Organic compounds	2,300	33%	15%	52%
Carbon monoxide	8,700	35%	16%	49%
Particulate matter	650	35%	11%	54%
	15,250 tons	5,000 tons	2,500 tons	7,750 tons
Percent	100%	33%	16%	51%

Source: Derived from Table 2, following page; source is the Air Pollution Survey Report, Air Pollution Emissions in the Delaware Valley for 1965, Drexel Institute of Technology.

Philadelphia emissions represent only one third of this vast amount of aerial garbage. Delaware County, with a total of approximately 2,500 tons per day, or about one sixth of the total, ranks second behind Philadelphia in the emission of each of the five major pollutants. The remaining nine counties, collectively, are responsible for approximately 7,600 tons per day, or slightly more than half of the total.

TABLE 2

Emissions of Air Pollutants in Delaware Valley, Annual Average For 1965 – Tons/Day

County / Pollutant	Bucks	Chester	Delaware	Mont-gomery	Phila.	Burling-ton	Camden	Glou-cester	Mercer	Salem	New Castle	Region Total
Oxides of Sulfur	80	165	446	168	782	110	80	107	246	125	288	2597
Oxides of Nitrogen	52	56	144	92	324	50	49	35	77	38	75	992
Organics	143	93	353	243	770	94	165	110	111	31	152	2265
Carbon Monoxide	506	322	1469	881	2917	342	648	474	422	86	596	8663
Benzo-pyrene *	6	6	6	11	59	4	9	2	6	1	5	115 *
Particulates	40	29	76	71	233	21	34	30	35	40	49	658
Total	821	665	2488	1455	5026	617	976	756	891	320	1160	15,175
Percent of Total	5	4	16	10	33	4	6	5	6	2	8	-

* lbs. per day

Major sources of pollutants are shown in Table 3, which establishes that electrical power generation, industrial operations, and transportation produce more than 80% of each of five major pollutants. Substantial improvement in the quality of our aerial environment clearly involves the production technologies of our economic system.

Table 3

Sources of Air Pollution Emissions
In the Delaware Valley - 1965

	Sulphur dioxide	Nitrogen oxides	Organic compounds	Carbon monoxide	Particulate matter
ELECTRICAL POWER GENERATION	48%	28%			15%
INDUSTRIAL OPERATIONS	44%	30%	30%	28%	61%
TRANSPORTATION	1%	27%	58%	70%	7%
Sub-Total	93%	85%	88%	98%	83%
Domestic Fuel	4%	11%	3%	1%	8%
Refuse		1%	3%	1%	7%
CIG Fuel*	3%	3%	1%		2%
Other			5%		
TOTAL	100%	100%	100%	100%	100%

*Commercial, Institutional, Governmental Fuel Burning.

The Philadelphia Region emission survey agrees with national data which show that close to 60% of the total emission tonnage is carbon monoxide, the motor vehicle being the principal source. Abatement efforts which fail to include control of vehicular emissions clearly cannot hope to effect a major improvement in total air quality within the Region. Such abatement efforts must be implemented primarily at Federal and state levels of government. Emergency controls, implemented regionally, may be required.

Other key findings from the Drexel emissions survey with broad implications for governmental organization include the following:

a. An estimated 85% of total emissions occurred within 10 miles on each side of the Delaware River. Penjerdel studies have estimated that at least 5/6ths of the Region's people live within ten miles of the river in 1/6th of the total land area.

b. The total of approximately 15,000 tons of pollutants was discharged into the atmosphere of the Region at essentially a constant rate throughout the year. The maximum monthly variation from the average was 6%, with individual pollutants varying from 3 to 15%. The relative constancy of emissions and the presence of all forms of injurious pollutants means that air pollution episodes can occur in the Region at any time of the year, and that the specific types of emissions must be identified in order for emergency measures to be directed at the proper sources and to result immediately in substantial improvement in atmospheric conditions.

In addition to these broad findings, conclusions concerning the three major types of emissions were presented by the Drexel Study in appendices.

With reference to emissions from transportation sources, the Philadelphia metropolitan area was found to have one of the country's greatest concentrations of vehicles per square mile. Assuming the continuation of the present rate of growth in both auto ownership and traffic density, the magnitude of vehicular emissions will continue to increase despite the effect of control devices on new automobiles and other vehicular transportation. Considering that approximately 6,000 tons/day of carbon monoxide were emitted from gasoline powered vehicles in this Region during 1965, substantial enforcement efforts on motor vehicle emissions are required.

Emissions from electric power generation were also expected to increase with new and additional demands for electricity. Electric power is presently generated by use of fossil fuels, releasing combustion products such as gases and solids. The Drexel data showed a considerable concentration of power generating stations along the Delaware River, extending from Wilmington north to Trenton. An average of 1,638 tons of pollutants per day was emitted during 1965. Abatement from electric power sources will depend on changes to low sulphur and ash fuels, development of atomic energy and other types of power, as well as installation of abatement devices.

Emissions from industrial fuel consumption and processing were examined with data on fuels used by the source categories listed in the Standard Industrial Classifications. Six of the SIC categories were found to consume approximately 80% of the total daily industrial energy. Of these six categories, (1) petroleum and coal products, (2) primary metal industries, and (3) chemicals and allied products were the leading three categories of emitters. Petroleum and coal products produced 74% of the total industrial pollutant tonnage from these six categories, which produced exactly eighty percent of all industrial emissions in 1965.

2. Major Findings of the Meteorological Analysis

While the emissions data unequivocably establish the potential for serious pollution conditions, the meteorological analysis indicates that only relatively favorable meteorological conditions have thus far prevented more frequent pollution episodes or emergencies in the Region. Two major findings which support this conclusion are as follows:

a. The air flow in relation to topographic features reveals that the concept of an air basin, or air shed, has no validity in the Penjerdel Region. Stated differently, no portion of the Region is any more or less prone to lowered air quality.

b. Peak concentrations of the various air pollutants do not occur simultaneously. This suggests that different emission patterns, in conjunction with meteorological conditions, are responsible for the different concentrations in particular areas.

To say that the Region is not a natural air basin or shed is not, however, to deny the importance of meteorological factors operating within the Region. Analysis of prevailing wind directions revealed only a slight shift in general wind flow from northwest in winter to southwest in summer. The basic direction of the air flow is from the west. Inspection of these prevailing wind patterns and directions permits only the conclusion that jurisdictions on both banks of the Delaware, but particularly jurisdictions in New Jersey, cannot hope to materially improve their air quality without an integrated, regional effort to control emissions.

The meteorological data tend to enforce the emissions study finding that pollution concentrates along the Delaware River. A fairly narrow band of high values of suspended particulates was found to run from northeast to southwest along the industrialized river valley from Trenton to Wilmington. It is assumed that gaseous and other pollutants would be distributed in the same general pattern.

The meteorological study also presented numerous findings on the potential for forecasting pollution episodes, including detailed case studies of January, 1967, November, 1966, and November, 1953. Key conclusions were as follows:

a. High pollution levels are not clearly related to a particular wind circulation pattern. Low pollution levels are associated with northwest winds and a polar continental air mass moving over the area from Canada. High pollution levels are associated with a weak high pressure system, light winds, and little or no precipitation.

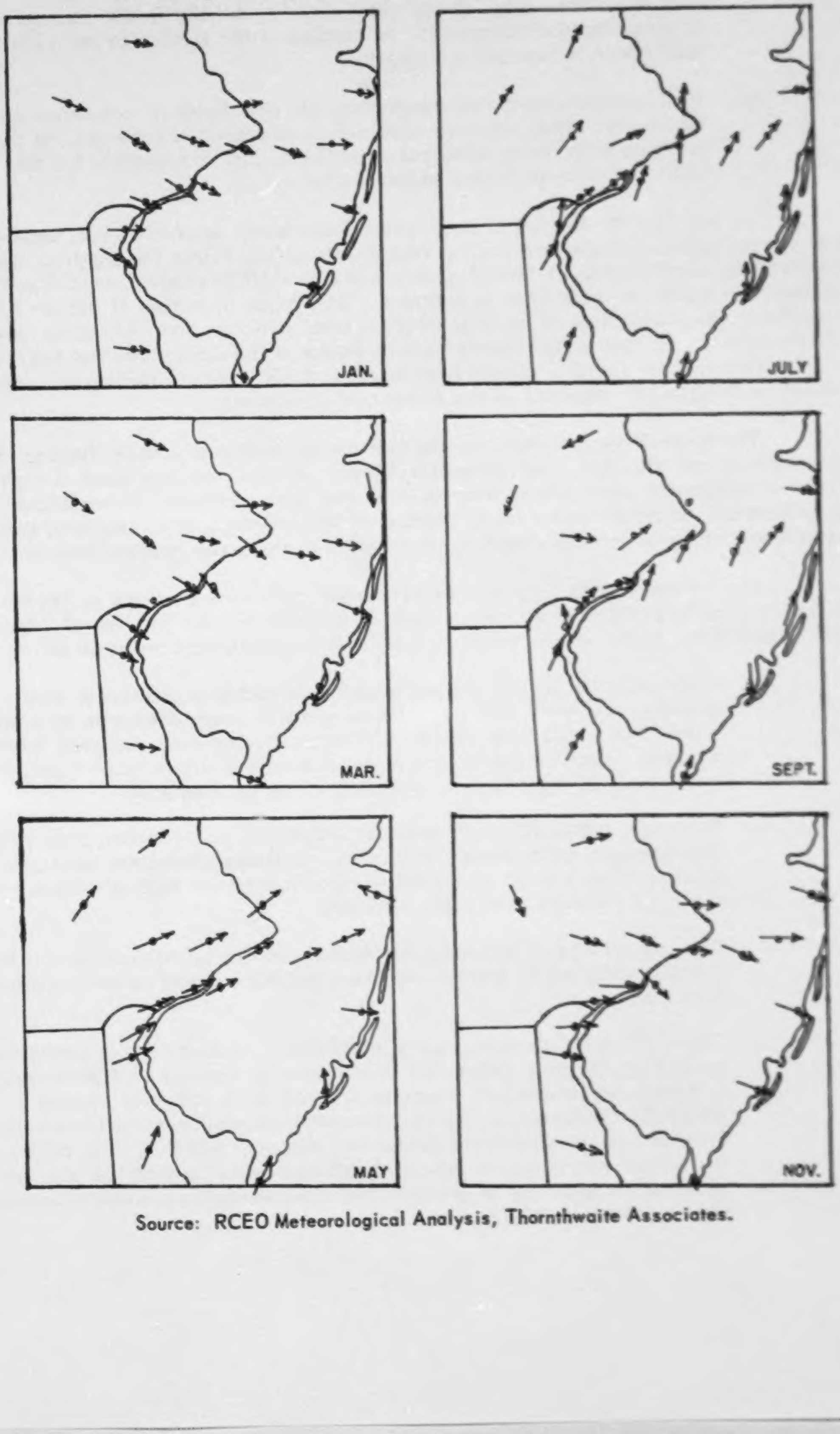
b. However, many different synoptic situations occur during high pollution periods, with enough differences in these situations and times when similar meteorological situations do not produce high pollution, to make forecasting extremely difficult.

c. The importance of non-climatic factors in air pollution makes it extremely difficult to predict pollution episodes based on meteorological data alone.

d. The stability of meteorological conditions, combined with non-meteorological factors, primarily presence of pollutants at higher concentrations, are important elements in predicting pollution episodes. While the frequency of limiting meteorological events favorable to episodes is most common in the late summer and fall, it is only in the winter that meteorological conditions combine with the abundance of pollution material to produce the most serious episodes at atmospheric pollution in this area.

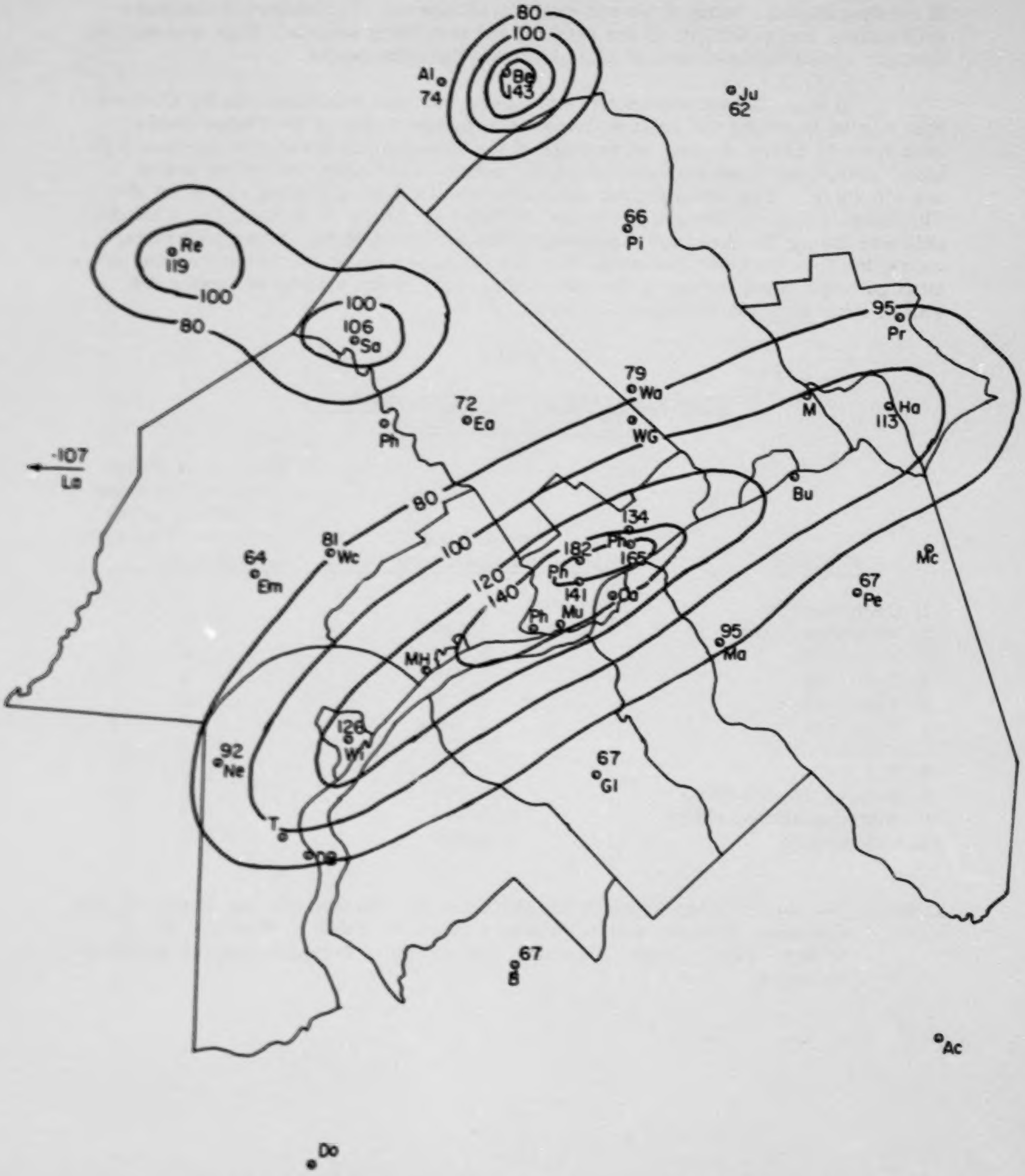
FIGURE 1

Prevailing Wind Direction (all velocities), Delaware Valley Area


JAN.
JULY
MAR.
SEPT.
MAY
NOV.

Source: RCEO Meteorological Analysis, Thornthwaite Associates.

FIGURE 2
Distribution of Average Suspended Particulate Concentration, 1965


80
100
Al
74
Be
143
Ju
62
Re
119
100
80
100
106
Sa
66
Pi
95
Pr
79
Wa
72
Ea
Ph
WG
M
Ha
113
-107
La
80
Bu
134
Ph
182
165
100
81
Wc
64
Em
120
140
Ph
141
Ca
Ph
Mu
Mc
67
Pe
95
Ma
MH
126
Wi
92
Ne
67
Gl
T
Ca
67
B
Ac
Do

Source: RCEO Meteorological Analysis, Thornthwaite Associates.

The Thornthwaite analysis further indicated that reliable wind observation stations are not well distributed in the 11-county area, with the records of a number of existing stations being of limited usefulness because of problems of exposure, calibration, and reliability of the sensors and recording system. This is a serious data gap hindering development of an accurate diffusion model.

In sum, the emissions and meteorological data establish that the Philadelphia Region is among the most polluted metropolitan areas of the United States. Data from 38 cities showing an average of the annual mean for eleven specific pollutants, measured in micrograms per cubic meter, were obtained for the health impact study. The comparative data confirm the high pollution status of the Philadelphia Region, and are presented in Table 4. Of the 38 U.S. cities, Philadelphia was among the three most polluted cities for seven of the eleven pollutants, among the five most polluted cities for nine of these pollutants, and among the seven most polluted cities for ten of the pollutants. Only in the amount of copper did Philadelphia rank low among the 38 cities.

Table 4

Philadelphia Annual Mean Concentrations For Selected Pollutants

Pollutant	Annual mean in micrograms per cubic meter	Ranking of Philadelphia in relation to other 38 cities in terms of severity of pollution
1. Cadmium (Cd)	0.033	2
2. Manganese (Mn)	0.495	2
3. Nickel (Ni)	0.079	3
4. Lead (Pb)	1.480	3
5. Vanadium (V)	0.238	3
6. Zinc (Zn)	1.437	3
7. Sulfates ($SO_4^=$)	22.650	3
8. Tin (Sn)	0.062	5
9. Sulphur dioxide (SO_2)	217.000	5
10. Nitrogen dioxide (NO_2)	107.000	7
11. Copper (Cu)	0.080	26

Source: The Relationship Between Air Pollution and Chronic Disease Rates (II. Air Pollution, Cancer, and Respiratory Disease, Table 1, Part 1.); R. J. Hickey, Ph. D., and colleagues, University of Pennsylvania, unpublished document.

B. Analysis of Basic Air Pollution Control Laws in Pennsylvania, New Jersey and Delaware*

1. Role of State and Local Governments in Air Pollution Control

At present, the effort to manage and control the quality of the Penjerdel regional atmosphere consists primarily of the separate and independent programs administered by Pennsylvania, New Jersey, Delaware, and the City of Philadelphia. There is, of course, increasing interest and involvement in air pollution matters by the Federal government. There is also minimal activity by widely scattered local governmental jurisdictions within the Region. But basic legal authority and operating responsibility remain with the three state governments. At present, the only structured way in which the three states relate their regional efforts is through an informal interstate cooperative agreement established in 1966 to effect coordination and cooperation in the management of the air in the "Delaware Valley Air Basin". The independence of action of the individual states, however, is in no way limited by the terms of this agreement.

The facts relating to the role of the state in this Region are also observable throughout the country and clearly support a general conclusion regarding the dominant role of state administered air pollution control programs. The conclusion does not indicate, however, the degree of turbulence which has and continues to surround the emergence of roles and patterns of responsibilities for air pollution control among levels of government. This turbulence is likely to continue until patterns which reflect effective resource management and enforcement control systems emerge. The role of the state will likely remain dominant, but an effective pattern will necessarily involve, to varying degrees, the resources and commitment of the Federal and local governments as well.

Governmental concern for the quality of the atmosphere is relatively new, and state government programs in air pollution are of extremely recent origin. Oregon created the first program in 1951. Until 1967, state programs have been totally a matter of state discretion and initiative. National legislation in 1955 and 1963 stated that the prevention and control of air pollution at its source was the primary responsibility of state and local governments. Under this Federal legislation the state "role" was what each individual state chose to make it. Prior to the 1963 Clean Air Act, only sixteen states had passed air pollution legislation. Federal financial assistance provided in the 1963 Act helped to bring to 37 the total number of states with statutes designed to control air pollution. But this Federal legislation did not require specific control actions to be taken by the states or otherwise mandate any necessary ingredients of a viable state program. For instance, only 13 of the 37 states with statutes covering air pollution had enacted air quality and emission standards or regulations. As of December 31, 1967, the United States Public Health Service found that 45 states and two territories had devised some form of air pollution control legislation.

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* This review and analysis of state statutes was prepared with the assistance of the Legislative Drafting Research Fund of the Columbia University Law School under the direction of Frank Grad, Esq., Associate Director of the Fund.

During this period from the early 1950's to 1967, the state's role was viewed primarily in terms of leadership, coordination, evaluation, service, and operations. Under these elements the states would develop comprehensive plans for air resource management, coordinate all environmental matters under state health activities, evaluate the air quality situation, and provide training services.

In operations, the primary state role was to assume responsibility for activities beyond the control of local agencies. Examples of such activities included handling air pollution emergencies, control of pollution from motor vehicles, and technical assistance. Comprehensive local programs were seen as the primary enforcement mechanism, with the state resolving jurisdictional problems and reserving the right to reassume delegated enforcement responsibilities. As late as 1961, the Air Hygiene Committee of the American Public Health Association recommended that local governments assume enforcement and other major air pollution functions, with the state's role limited to (1) enactment of enabling legislation to clarify the authority of state and local agencies, (2) long-range planning, (3) research on effects and emergency episodes, (4) air quality monitoring, and (5) assistance to local governments. As will be shown in the survey of local governments in the Penjerdel Region, such reliance on local governments was not a realistic method of obtaining substantial regulatory action. In this Region, it should be noted, New Jersey (1954), Delaware (1957), and Pennsylvania (1960) early assumed primary responsibility for air pollution control.

The Air Quality Act of 1967 brought a fundamental shift in that the state "role" was in part prescribed by Federal legislation. Certain basic state government activities and requirements in air resource management and control are explicitly stated and no longer merely a matter of state discretion. Initial responsibility and authority for developing air resource management and control systems still rest with the states, but the substance, timing and implementation of that initiative are now a matter of Federal legislative policy. The states must adopt air quality standards and "...a plan for the implementation, maintenance, and enforcement of such standards..." (Section 108, c). A timetable for state accomplishment of these steps is written into the Federal law. Federal standard setting and enforcement powers are provided if the states do not respond adequately. The use by states of interstate compacts for air pollution control must meet the legal requirement that the area covered by such compacts conform geographically to air quality control regions designated by the Federal government.

Thus, the 1967 Act has the effect of making the state role more definitive and stable, and, in this connection, to regularize and schedule the involvement and activities of the Federal government in air pollution control matters. The role of local government can be established or altered by the state to conform with state plans and enforcement policies. While the state has authority to determine the structure and function of local government in air pollution control, it is clear that the role of local government can no longer be that of the primary enforcement agency.

In examining the existing governmental response to the regional air pollution problem, therefore, it becomes important to review the basic state statutes in Pennsylvania, New Jersey and Delaware and to briefly survey the organization and programs of the respective states and Philadelphia. Air pollution control activities of other local governments throughout the Region will be reviewed and briefly summarized. The purpose of this examination of the existing regional response is not to present a comprehensive, detailed evaluation of present programs. The intent is to present a general description of the overall governmental response in the light of defined Regional air pollution control needs and as a point of departure in proposing the optimum governmental response to meet those needs.

2. General Characteristics of Basic Air Pollution Laws in Pennsylvania, New Jersey and Delaware

The basic statutes for the regulation of air quality in the Penjerdel Region were all enacted within the last 20 years, and significantly amended within the last two years. In each of these Penjerdel states, the statutes establish specialized administrative structures with rule-making and enforcement powers against pollution. Predating these comprehensive State laws were numerous local enactments, ranging from simple ordinances against open fires and the like to detailed pollution controls by local councils, air pollution agencies, or boards of health, and older state laws prohibiting specific offensive practices or generally proscribing nuisances. Authorization of regional, interstate air quality systems may be seen in current law only in the few cases of state enactment of compacts and the occasional authorization to state agencies to engage in interstate cooperative activities.

The air pollution control laws of Delaware, New Jersey and Pennsylvania have many characteristics in common; indeed, the structure of nearly all modern state laws on the subject is similar. The characteristic features of the legal process of air quality regulation and enforcement, and the specific problems involved, are described elsewhere in this Report. In most of these respects, the laws of the three states are typical. Thus, for example, all three statutes leave the task of providing what shall be prohibited (with the possible exception of a general provision against nuisances) entirely to the responsible agency, within policies set out in the law. All three prescribe in some detail - with variations reflecting the state's general treatment of administrative agencies - the procedural protections of notice, formal hearings, protection of trade secrets, right of appeal, and so on, that regulate the agency's exercise of power. All three authorize use of the several different enforcement devices that may be appropriate, including issuance of specific orders, proceedings leading to civil and/or criminal fines levied on a *per diem* basis, injunctions against violators, some form of licensing or power of prior control, and some summary powers for emergencies or hazardous conditions. The more significant special characteristics of each of these three statutes will be summarized later. A few general conclusions about the three laws taken together might be stated as follows:

a. The basic regulatory authority, though not necessarily all of the procedural provisions implementing it, is at least in theory broad enough to authorize comprehensive air quality controls. The basic definitions cover air contaminants generally and define air pollution in terms of the presence of contaminants which are injurious *or* unreasonably interfere with the enjoyment of life or property, thus going beyond mere restriction of hazardous pollution. Yet there are definite evidentiary difficulties associated with that portion of the definition that requires proof of inquiry. The power to promulgate standards is given in essentially unqualified terms (*e.g.*, "regulations for the control of air pollution"). To the extent that the state agencies may be unable to act freely, the limitations are less in the basic grants of powers than in policy statements in the statutes relating to feasibility and the consideration of economic interests, or in administrative or procedural provisions.

b. The history of these laws reflects the practice, almost universal in the early stages of regulation of this type, of giving the regulated interests a substantial voice -- not merely through consultations and advisory committees, but through actual membership in the governing body and thus in the process of rule making. Indeed, until 1966 each of the three state laws lodged the rule-making power in a body whose membership was composed of a substantial number, even a majority, of appointed industrial representatives. The original 1954 New Jersey statute went so far as to provide for appointment of certain members on the nomination of industrial organizations. This form of representation ended in Delaware in 1966 as a consequence of the absorption of air pollution control within a more general agency primarily oriented toward water resources development. New Jersey took the comparatively radical step, as part of its 1967 amendments strengthening the 1954 law, of abolishing the rule-making board entirely and transferring its power to the responsible enforcement agency, the Department of Health. Industrial, professional and other public representation is preserved in a new Clean Air Council which has only advisory functions. Amendments to the basic 1960 Pennsylvania legislation, passed in 1968, change slightly the industrial composition of the Commission, but leave it with rule-making authority.

c. More broadly, these laws reflect the conflicting drives toward a voluntary approach stressing the development of a consensus among the regulated interests and a law-enforcement approach emphasizing direct and immediate action by the agency. As air pollution control has become a matter of greater public concern, amendments to state laws have generally authorized more direct resort to enforcement. The change is not always a complete swing in this direction, however. Thus, Delaware, as a result of the new provisions bringing air pollution control together with water resource management, appears to require that all violations be dealt with initially - except where summary action is authorized - by "conference, conciliation or persuasion", with formal proceedings to follow only if this fails. (See 7 Del. Code §§6006, 6204). Prior law contained no such provision.

d. All of the statutes prescribe in a comparatively detailed fashion the form which administrative proceedings should take -- particularly the notice and hearing requirements. Specific formal requirements are set out with respect to rule making as well as proceedings arising out of alleged violations. The laws contemplate that these procedures will ordinarily precede court action, although this is not always a legal requirement.

Whether or not the administrative proceedings are a prerequisite to court action may depend on the precise wording of the legislation. For example, under the 1967 amendment of New Jersey's statute, injunctions may be sought against violations of the law, the Department's rules, or a departmental order, rather than only for violation of an order. (26 N.J. Stat. Ann. §2C-19, as amended by N.J. Laws 1967, ch. 105, §1.) This means in effect that injunctions may now be sought, where deemed appropriate, in the first instance against a violator, rather than only after departmental proceedings have produced an order that has not been complied with.

e. Considerable complexity arises from the attempt of the state statutes to preserve both local interests and pre-existing rules of law which may be affected by the powers of the pollution control agency. Deference to local interests takes two forms. First, rule making by the state agency is to take into account local differences, and a local voice may be provided in the process. Thus, under the 1960 Pennsylvania law, rule making by the State Air Pollution Commission is to take place in a regional context. Proposed rules, as well as complaints against pollution affecting only one region, are to be referred in the first instance to Regional Air Pollution Control Associations established under the Act. Under the June, 1968 amendments the absolute referral requirement is eliminated. The original New Jersey legislation provided for County Air Pollution Control Associations with a more limited advisory role than the Pennsylvania Regional Associations. The New Jersey associations were abolished in the 1967 revision of the Act. The Delaware law does not provide for such subsidiary organizations, but the governing Commission itself is organized on the basis of geographical representation, and the grant to it of air pollution control powers is accompanied by an unusually detailed and emphatic directive to take into account local characteristics in its rule-making process (7 Del. Code §6302 (b)). Second, the State statutes provide that they do not remove local jurisdiction that would otherwise exist, so long as local rules are not inconsistent with the state provisions and not less restrictive. Similarly, each of the statutes contains various provisions preserving the effect of other rules of law that overlap with air pollution control, including specifically the historic right of government to seek injunctions to abate public nuisances. The 1968 amendments to the Pennsylvania law insert a new section (12.1) preserving rights and remedies to abate public and private nuisances.

f. Finally, it is with regard to these last two points - the relationship of the state air pollution control laws to local laws and to pre-existing remedies against the same evils - that the greatest problems in interpretation of these statutes have arisen. The actual processes of rule making and enforcement by the state agencies are not ordinarily likely to pose substantial legal difficulties either within the agencies or before the courts, so long as there is compliance with prescribed procedures. The delegation of extensive powers in areas such as these to specialized and presumably expert administrative agencies is no longer novel or widely challenged; and, particularly in a public policy area as technical and as rapidly-changing as air pollution, courts are increasingly reluctant to replace the agency's judgment with their own. Indeed, if anything, the agency may be more open to challenge when it does not exercise its specialized discretion, when it issues violation notices and orders that duplicate the words of the statutes and codes, rather than issuing specific instructions to meet the particular case. But, when the effect of the state air pollution law and action thereunder on other avenues of enforcement arises, legal problems of much greater complexity arise. It is a striking fact that even with the comparatively little that the courts have had to do with these laws thus far - the Delaware, New Jersey, and Pennsylvania statutes, taken together, have not yet been involved in even a dozen reported cases - each of the three states' courts has had difficulty with this issue of the air pollution law's effect on other laws.

New Jersey's courts first determined that the State act barred local pollution ordinances that set more restrictive standards, and later implied that the case might be different under the 1967 amendment permitting "more stringent" provisions. In each case the decision was rested more confidently on grounds related to the general restrictions on municipal lawmaking. Delaware's Court of Chancery first ruled that the State's 1957 air pollution control law barred private court actions, at least until the administrative proceedings were pursued. Later the Chancery Court reversed itself on this issue and ruled that the equity court's basic jurisdiction over the matter could not validly be taken away, or at least would not be construed to do so unless the statute said so in so many words. The Supreme Court of Pennsylvania divided four-to-three in ruling that the air pollution control procedure set up by the law barred suits, even by the Commonwealth, to enjoin pollution constituting a public nuisance, despite language in the act preserving the powers of the Department of Health "to control and abate nuisances". The statute was amended in 1966, and further amended in 1968, to negate this decision.

3. The Pennsylvania Statute: Summary Analysis

The 1960 Pennsylvania air pollution control law (Chapter 23 of Title 35 of the Pennsylvania Statutes, Act of January 8, 1960 (P. L. 2119)) represented perhaps the most specific and direct degree of deference to local considerations and to the interests of the regulated private interests involved.

The 1960 statute's declaration of policy provided:

> It is hereby determined and declared to be the policy of the Commonwealth of Pennsylvania to maintain such a reasonable degree of purity of the air resources of the Commonwealth as shall be technically feasible, economically reasonable, and necessary for the protection of the normal health, the general welfare and the property of the people of the Commonwealth. The measures for the accomplishment of this purpose shall not unreasonably obstruct the attraction, development and expansion of business, industry and commerce within the Commonwealth, but shall be technically feasible and economically reasonable. The program for the control of air pollution under this act shall be undertaken in a progressive manner, and each of its successive objectives shall be sought to be accomplished by a maximum of cooperation and conciliation among all the parties concerned. All powers herein conferred upon the Department of Health, the Air Pollution Commission, or any Regional Air

> Pollution Control Association, and all powers herein reserved to any political subdivision shall be exercised solely to effectuate the policy declared in this section. (35 Pa. Statutes 4002)

Amendments to the 1960 Act, signed into law on June 12, 1968, included a new and improved statement of policy as follows:

> . . . to protect the air resources of the Commonwealth to the degree necessary for the (i) protection of public health, safety and well-being of its citizens; (ii) prevention of injury to plant and animal life and to property; (iii) protection of the comfort and convenience of the public and protection of the recreational resources of the Commonwealth; and (iv) development, attraction and expansion of industry, commerce and agriculture.
> (Report of the Committee of Conference on House Bill No. No. 926, Printer's No. 3422)

The new declaration of policy does represent a significant improvement by eliminating the rigidities inherent in the heavy reliance on cooperation and conciliation, and the pronounced emphasis on industrial development protection and economic reasonableness. Other amendments in the 1968 revision, however, made only minor changes in the basic 1960 statute and the enforcement procedures to be followed.

The 1960 act established an Air Pollution Commission in the Department of Health, consisting of five state department heads and six public members appointed by the Governor: one from the general public, one toxicologist, one engineer experienced in air pollution control matters, and three members representative of and employed by industrial or public utility companies doing business within the State. Under one of the 1968 amendments the composition of the Commission was altered: there are still five departmental Secretaries, though the departments represented have shifted; the six public members are one duly licensed professional engineer, two members of groups concerned with conservation of natural resources, two engineers from industry, and one member of the general public. The legal requirement for direct industrial representation is thus reduced. Also, under the 1960 composition, the importance of industry's representation was greater because the Commission was not only the rule-making authority but, in formal matters, the enforcement authority. That is, orders against violators were issued by the Commission and not the Department. The Department performed the actual functions of enforcement at the Commission's direction and was delegated such Commission powers as the holding of hearings, although the final determination was vested in the Commission.

The 1960 act provided that rule-making and enforcement should take place on a regional basis. The Commission was directed to establish regions within the State; for each region the Governor appointed a Regional Air Pollution Control association consisting of one representative of industry, one of labor, and a county commissioner from one of the counties included in the region, plus one additional resident of each such county. Rules were to be adopted covering one or more regions, after the Commission has given the Association(s) affected time to review and comment on the proposed regulations. Enforcement also involved the local agencies. Complaints were required to be submitted by the Department to the Association covering the region. The law required that the Regional Association "shall attempt through the use of maximum of conference, conciliation and persuasion" to bring about compliance. Complaints affecting one or more regions other than that in which the source is located were referred directly to the Commission. The Department had to report to the Commission within a maximum of six months; if not successful, it had to refer the complaint to the Commission; if successful, the proceeding was at an end. If any new complaint concerning the same violator was made within the next 60 days, the complaint had to go directly to the Commission.

Alterations were made in the powers of the Department, the Commission, and the Associations by the 1968 amendments. In general, the initial enforcement powers of the Commission were transferred to the Department, and the relationship of the Regional Associations to both the Department and the Commission was altered.

The Department of Health, under the 1968 amendments:

- Receives and refers all complaints to the Regional Association in the region in which the air contamination source is located, rather than to the Commission in cases where the source is in one region and the effect is in another.
- Issues orders to persons causing air pollution, a power previously possessed solely by the Commission. It also should be noted that under the 1960 law, orders could be issued only following a hearing by the Commission. Under the 1968 amendments, orders can be issued by the Department with hearings to be held by the Commission only in the case of appeals;
- Institutes court proceedings to enforce its orders without having to receive the direction of the Commission;
- Institutes prosecutions under the act, in place of enforcing Commission orders;
- Requires submission of plans and specifications for air pollution control devices, without prior request of the Commission;
- Makes application for "an injunction to restrain all violations of this act" to the Attorney General, rather than the Commission making such application.

The Air Pollution Control Commission, under the 1968 amendments:

- Adopts policies and regulations for the enforcement of regulations adopted for the control of air pollution;
- Hears and determines all appeals from orders issued by the Department, rather than hearing complaints of alleged violations of the Commission's rules and regulations;

- Classifies air contaminant sources and receives reports which it may require concerning the source. This is a new grant of authority.

The Regional Air Pollution Control Associations, under the 1968 amendments, are now empowered:

- Only to resolve complaints through conferences, conciliation, and persuasion, and not to abate, control, reduce or prevent air pollution within the region;

- Report to the Department within three months of receipt of a complaint, rather than within six months to the Commission as previously provided;

- Refer repeat complaints concerning a source within 60 days to the Department, rather than to the Commission.

Penalties for summary offenses were raised from not less than $30 and not more than $300, to not less than $100 and not more than $500; penalties for misdemeanors remained unchanged.

While several important powers have been transferred from the Commission to the Department and procedures have been accelerated slightly, the new grant of authority to the Commission to adopt policies which govern enforcement of regulations - which only the Commission can adopt - makes it clear that the Commission is still the repository of basic enforcement power. It would appear that the Commission can make policies concerning when the Department can institute judicial proceedings and prosecutions, despite the appearance that the Department now has the sole authority in such matters. However, the initiative for enforcement actions has shifted from the Commission to the Department.

It is notable that the leading Pennsylvania case construing the 1960 statute held that the existence of procedures under the act took away the right, even of the State, to sue for an injunction against air pollution constituting a nuisance, without a showing of irreparable harm, if the administrative procedures were used. The statute as originally enacted provided that it did not limit the Department's power "to control and abate nuisances detrimental to the public health". Nevertheless, the Supreme Court of Pennsylvania in Commonwealth v. Glen Alden Corp., 418 Pa. 57, 210 A. 2d 256 (1965), held that this reference was to statutes authorizing direct action by the Department, and did not preserve the right to sue to abate the nuisance. The Court, in a four-to-three decision, ruled that the air pollution act was intended to provide an exclusive administrative remedy, that where a statutory scheme of regulation was established its terms had to be followed. The decision was overruled by a 1966 amendment to the Act, which provided that the powers of the Department, including the power to seek a court order abating a condition, and the jurisdiction of the courts to issue such orders, are unimpaired except where it would cause a "clear and direct conflict with a rule, regulation or order of the Commission". This decision was reaffirmed and clarified in the 1968 amendments. (35 Pa. Stat. §4011.)

4. The New Jersey Statute: Summary Analysis

New Jersey's air pollution control act (Chapter 2C of Title 26 of the New Jersey Revised Statutes), originally enacted in 1954, was amended in several important respects in 1967. The New Jersey statutes now represent the strongest and most enforcement-oriented statute of its type in the Penjerdel Region, and perhaps in the nation. One fundamental change was the abolition of the Air Pollution Control Commission within the State Department of Health and the transferrence of the Commission's rule-making authority to the Department itself. An advisory Clean Air Council, with private-interest representation somewhat similar to that existing on the Commission, was established. (N. J. Laws 1967, ch. 106.) This delegation of rule-making power to the Department of Health is particularly striking since, as noted, the statutes themselves set no air quality requirements or even criteria. In effect, the enforcement agency has the power and responsibility to create the standards. The same act also abolished the former advisory County Air Pollution Associations. The Department, like the Commission before it, has full discretion as to the geographical scope of its regulations ("throughout the State or in such territories of the State as shall be affected thereby"; N. J. Rev. Stat. §26:2C-8). The rule-making power is given in comprehensive terms and includes licensure; indeed, the act itself provides a requirement for permits for potential pollution sources and control equipment, except as the Department's rules may prescribe exceptions. Certificates to operate such equipment are required, and are not to be issued unless the Department is satisfied that they will operate in compliance with its standards and incorporate current advances in the art of pollution control. Renewals are required at intervals of five years. (N. J. Rev. Stat. §26:2C9.2; the section provides an exception for certain small dwellings.)

The general enforcement provisions are equally strong. The Department may issue an order calling for any steps necessary to achieve compliance upon discovering a violation; a hearing will follow on demand of the party affected. However, if an existing code or regulation does not impose specific emission requirements with respect to the particular type of emission, a preliminary hearing must be held before issuance of the order. The provisions for court action against violations were considerably strengthened by the 1967 amendments. Injunctions may now be sought directly for violations of the law and codes themselves, as well as in the case of disobedience to a departmental order. Summary proceedings are authorized. The maximum civil penalty was increased from $500 a week to $2,500 a day, running from the time prescribed in the order. The Department is authorized to compromise its claims for these penalties and specifically to rebate up to 90% of the penalty if the violator shows "within 1 year or such other period as the department may deem reasonable" that its requirements have been met. (§26:2C-19, as amended by N. J. Laws 1967, ch. 105.) The provision for a financial penalty that in a fairly short time could amount to considerable sums, coupled with the authority to forgive nearly all of it if the violator moves in good faith to comply, provides the possibility of a meaningful financial incentive to compliance.

Another one of the 1967 package of amendments, Chapter 108 of the New Jersey Laws of 1967, supplements the basic 1954 act with a sweeping "Air Pollution Emergency Control Act" (§§26:2C-26 to 26:2C-36). The Act provides that if the Commissioner of Health determines that air pollution constitutes "an unreasonable and emergency risk to the health of those present" in any area of the State, the Governor may by proclamation declare an air pollution emergency. During such a declared emergency, he may by order "prohibit, restrict or condition" vehicle movements, business activities, the operation of incinerators, the use of fuel, any other form of burning, or "any or all other activity in the area which contributes or may contribute to the air pollution emergency". The "area" may include any place in which pollution contributing to the emergency originates, as well as the territory affected. Orders are effective at once without the need of court action, may be enforced forthwith (if necessary by physically terminating the prohibited activity) by all pollution control and law-enforcement officers, and carry a penalty of up to ten years' imprisonment and a $100,000 fine for knowing violation. Persons seeking modification or termination of any provision of any order may obtain a hearing before the Commissioner, who shall then make recommendations to the Governor. Orders remain in effect until a specified termination time, until further gubernatorial orders revoking or modifying them, or until a proclamation terminates the state of emergency. To permit effective action if an emergency arises, the Commissioner is directed to develop and publicize proposed stand-by orders, and enforcement arrangements, for use in air pollution emergencies.

The 1967 amendments also clarify the effect of the State law on local pollution control efforts by providing specifically that local regulations can be "more stringent" than those imposed by the State. Further, the act now provides that the right to enact these local regulations is "subject to the approval of the department". Thus the responsible agency itself will make the determination of whether local regulations are compatible with its programs, eliminating the problem faced by courts in trying to make such a decision based on a vague statutory formula.

5. The Delaware Statute: Summary Analysis

The most notable characteristic of Delaware's air pollution control legislation is its attempt to treat air quality as an aspect of management of the state's water and air resources generally. A 1966 statute (55 Del. Laws, Ch. 442) establishes a Water and Air Resources Commission with general power over the preservation, planning and development of the state's water and air resources and specific authority in the fields of water resource allocation, air and water pollution, and control of use of the State's tidelands and land under water. The prior air pollution control legislation, 51 Del. Laws, Ch. 152 (1957), which established an Air Pollution Authority under the State Board of Health, was repealed. Thus, Delaware's air pollution law now appears in the subdivision of its state code dealing with conservation rather than, as is ordinarily the case, under health. (The 1966 act added a new Part VII (Chapter 60-64) to Title 7 (Conservation) of the Delaware Code: Chapter 60, dealing with the Commission generally, and Chapter 62, on air pollution, are the relevant portions.) The Commission has broad powers over the water and air resources of the State, viewed as an interrelated system demanding overall planning and management at the State level.

A comprehensive statewide approach of this nature may be particularly appropriate in the case of Delaware, a very small state lying along the shore of a single great river and bay. Incorporation of air pollution control into a structure of this kind may, however, create complications. While air is now recognized as a scarce natural resource which must be maintained, it is not really analogous to water. Government does not develop, manage, or allocate the use of its air resources in the same sense that it manages or allocates water; it seeks primarily to prevent the discharge of contaminants into the air. The planning and operating activities in air pollution, however important they may be considered, are still only adjuncts to this essentially negative process of regulation and enforcement. Even water pollution control, though more closely analogous to air regulation, is not regulatory in the same sense.

This suggests two difficulties in placing air quality control under an agency whose primary concern is with water resources. The first is that the types of functions differ, so that the legal and procedural framework established for the water agency may not be the most effective for air pollution control. For example, the chapter setting forth the general powers of Delaware's Commission emphasizes conferences and other voluntary procedures. This emphasis is natural given the Act's policy statements which, as is completely proper in the case of water resource planning, stress cooperative programs among the affected interests. But the chapter of the act dealing with air pollution, incorporating by reference the same procedures, makes enforcement generally dependent on these preliminary steps, which would seem to place an inappropriate burden on the control process.

The second possible problem is that while one agency may well be qualified to handle the many aspects of water development, control, and planning, all of which are related, the same expertise will not necessarily extend to the subject of air quality control. The Delaware River Basin Commission, for example, has been given a long list of planning, operating, regulatory and other functions on matters ranging from stream pollution to hydroelectric power. But all of these relate to a single process, the management of the Delaware River and its tributaries. Attempts to assign air pollution functions to an agency concerned with water control, as in the case of New York and New Jersey's Interstate Sanitation Commission, have not been entirely successful. An air pollution agency's activities relate less to those of a water agency than to those of public health agencies and agencies involved with solid waste disposal.

Delaware's Water and Air Resources Commission, however, has Wilmington's Water Commissioner, representing the State's most important water user, as a member and gives non-voting membership to the state geologist and the Governor's representative on the Delaware River Basin Commission, but it has no ties to the State Board of Health. Air pollution control enforcement is ordinarily assigned to a health department, which has similar responsibilities in other areas, or to an independent agency, either a separate department or the staff of the governing commission.

In this connection, it should be noted that in Delaware, enforcement as well as rule-making is assigned to the Commission itself, not to its staff, although the actual business of presiding at the hearings may be delegated. (See 7 Del. Code §§6006-09.)

The Delaware Water and Air Resources Commission is given rule-making and related regulatory powers in broad terms, including language that constitutes, in effect, authority to impose permit requirements (e.g., §§6203 (a)(5), (7)). Enforcement proceedings are, as noted above, required to follow the detailed sequence prescribed for the Commission's actions generally: (1) attempts to secure voluntary compliance, (2) formal notice of violation, and (3) formal hearing, after which the Commission may issue its definitive order. A $500-per-day penalty, running from initial notice of violation, may be imposed for failure to comply with rules or orders

(§§6013 (a)). The Commission may also obtain injunctions, but only where there is failure to comply with its final order (§§6205). Summary proceedings, under which an order may be issued effective immediately with hearings to follow on demand "as promptly as possible thereafter", are authorized "whenever conditions are such as to require immediate action to protect the public health" (§§6206). This would apparently cover any instance of particular emissions creating a hazard as well as a more general air pollution emergency, and thus may modify somewhat the rigors of the above requirements.

The basic prohibition of the 1957 law against any discharge of pollutants which constitutes a public nuisance is preserved, and, in effect, permits court and administrative action by the Commission in such situations regardless of whether they are covered by its own air pollution code (§§6231-33). Despite this procedure, such nuisances may be proceeded against in court entirely independently of the Act. The courts had originally ruled that a suit to abate pollution, even if it constituted a nuisance under general law, was premature until the Commission's proceedings had been invoked, and implied that in any event such suits could only be brought by the State. Schofield v. Material Transit, Inc., 42 Del. Chancery 144, 206 A. 2d 100 (1960). This decision was later in effect overruled, the court holding that a constitutional doctrine against diminution of the court's equity jurisdiction prohibited transferring even the initial decision-making authority to the administrative agency, at least in the absence of very specific language in the statute to the effect that its procedures were exclusive. Pottock v. Continental Can Co., 42 Del. Chancery 296, 210 A. 2d 295 (1965).

One unusual aspect of the Delaware statute, probably related to the state's geographical situation, is the extent to which it recognizes the importance of present and future interstate action. The Commission is encouraged in the Act's general statement of policies to cooperate with other agencies, including interstate bodies (§§6001 (c) (5)) and is specifically authorized to "represent this State in any and all matters pertaining to plans, procedures or negotiations for interstate compacts in relation to air pollution control" (§§6203 (a) (13)). As previously noted, the state's representative to the Delaware River Basin Commission is an ex officio member, without vote, of the Water and Air Resources Commission (§6002 (b)).

C. Review and Analysis of Existing Air Pollution Control Programs in the Penjerdel Region

1. The Pennsylvania State Air Pollution Control Program

a. Background and Organization

The Donora incident, used internationally as an example of excess deaths under inversion conditions, provided the genesis of the Pennsylvania air pollution program. Following the October, 1948 episode in Donora, Pennsylvania, and a subsequent investigation of air pollution conducted by the State Department of Health, control activities were initiated under the Division of Industrial Hygiene. This early air pollution control program operated under the provisions of the Pennsylvania Administrative Code of 1929. From this beginning in crisis, a dozen years passed before the passage of the basic air pollution legislation of Pennsylvania, (Act of January 8, 1960, P. L. 2119) which created the State Air Pollution

Commission. Responsibility for air pollution was placed in a Division of Air Pollution Control within the Health Department.

In launching the work of the Division of Air Pollution Control, the Commonwealth first undertook a state-wide air pollution survey. Conducted jointly by the Pennsylvania Department of Health and the United States Public Health Service of the Department of Health, Education, and Welfare, the report was released in November, 1961, entitled "Pure Air for Pennsylvania". Completion of this report was followed by initial development of the Pennsylvania air pollution program. The 1962-64 program plan for the Division, the first to be prepared, summarized the general findings of the "Pure Air" study as follows:

- 801 communities with population over 2,500 were surveyed: of these, 476 had objectionable amounts of air pollution, nearly 100 had major problems, and over half of these were due to pollution sources outside the affected area.

- "Significant instances of reduced visibility, metal corrosion, property damage, personal discomfort and health effects have been recorded."

- Levels of contaminants when correlated with meteorological data, show that "...there are a large number of problem areas in the State. This information also points out a number of communities that have the potential of becoming serious problem areas".

Prime sources of information used in the 1961 study were interviews with local officials, mail survey of industrial employers, and development of new data, but not actual air sampling. A summary of the more significant and explicit findings extracted from the 1961 study includes the following:

(1) Process emissions from the manufacturing industries are major problems in many areas of the State, independent of community size. 347 communities reported effects of such process emissions, 69% of these specifying primary metals, fabricated metals and machinery, petroleum refining, chemical products, or stone and clay industries.

(2) Practically every major source of air pollution can be classified as arising from either a combustion operation or an industrial process. Problems from fuel combustion will continue to increase with growth in population and those from industrial processes will also become more prevalent.

(3) While noting that the possible physiological significance of air pollution was yet to be determined, the report did state that "...vital statistics for the State suggest that air pollution in certain communities may be a contributing cause for an excess number of deaths". Air pollution was suspected as a contributory cause for differences between urban and rural death rates for respiratory cancer.

(4) Manufacturing establishments employing more than 100 persons were surveyed; less than half of these replied with any data on the engineering control of their air pollution emissions. Of those replying just one in five reported any form of air pollution control installations.

Based on these specific findings, the 1962-64 program plan listed the major elements of the Pennsylvania program objectives and the methods to be used in reaching these objectives as follows:

(1) Detect and determine the nature and extent of air pollution in the Commonwealth,

- conduct community and area air sampling programs,

- maintain an inventory of quantities of pollutants released in the atmosphere,

- inspect air pollution problems and investigate air pollution complaints. In subsequent program plans these methods were modified to include defining the Commonwealth's air resources by developing new sampling and evaluation techniques, and conducting statewide air sampling programs.

(2) Abate and control existing air pollution by

- developing and promulgating rules and regulations, including enforcement,

- assisting the Commission in adopting regulations,

- providing assistance to municipal governments, industries and other agencies interested in air pollution.

(3) Prevent air pollution by

- enforcement of regulations once adopted,

- obtaining voluntary compliance.

The methods to obtain these objectives have evolved into the major components of the Pennsylvania program: (1) community surveys and air monitoring; (2) operation of an abatement and complaints system under regulations adopted by the Commission; and (3) operation of a permit system aimed at the prevention of air pollution.

The Division of Air Pollution Control is under the Bureau of Environmental Health, within the State Department of Health. The Air Pollution Commission and the seven regional associations are not a part of the Department, but are composed of individuals appointed by the Governor. The Division of Air Pollution Control also contains seven regional offices, which operate in conjunction with the Regional Associations. Under a program director, the Division of Air Pollution Control is divided into three sections, each having responsibility for one of the broad program categories of the Division: (1) the technical services division is most directly involved with determining the extent of air pollution in the Commonwealth through measuring and detecting contaminants in the atmosphere; (2) the abatement and compliance section is concerned with enforcement and voluntary compliance to control and prevent air pollution; and (3) the air resource management section handles the non-technical or non-regulatory elements of the program, including certain forms of community assistance, drafting of regulations, personnel recruitment, and other program administration elements. The seven regional offices handle the technical execution of the control programs, and operate in cooperation with the seven regions of the State Department of Health. Only Region VII, made up of Bucks, Chester, Delaware and Montgomery Counties, is of direct concern to the Penjerdel Region. Philadelphia operates its own approved program under the Home Rule Charter.

Changes in the responsibilities of the Health Department, the Commission and the Regional Associations have been described in the analysis of the Pennsylvania statute. It is appropriate, however, to summarize the primary responsibilities of these agencies as they exist following the 1968 amendments to the basic Pennsylvania legislation.

The Department of Health

- Investigate sources of pollution;
- Initiate and receive complaints, and submit such complaints to the appropriate Regional Association;
- Issue orders to any person causing air pollution;
- Institute judicial proceedings to compel compliance and prosecutions under the act;
- Require submission of plans and specifications for control devices and equipment;
- Conduct studies on the causes and effects of air contaminants;
- Prepare a general comprehensive plan for the control and abatement of existing sources and the prevention of new contamination;
- Encourage local control agencies and provide technical consultative services;
- Encourage voluntary efforts and conduct educational programs.

The Air Pollution Commission

- Adopt rules and regulations for the control of air pollution;
- Adopt policies and regulations for the enforcement of the rules and regulations noted above;
- Hear and determine all appeals from orders of the Department;
- Establish and publish maximum quantities of air contaminants (emission standards of a type) that may be permitted at various points;
- Classify air contaminants and require reporting concerning the emissions.

Regional Air Pollution Control Associations

- Consider complaints regarding any air contamination source within its region, and attempt to resolve the complaint by means of cooperation and conciliation;
- Review and comment on all proposed regulations of the Commission peculiar to the region within 90 days.

b. Air Pollution Regulations

As of June, 1968, the Pennsylvania Air Pollution Commission had adopted four regulations since its creation in 1960. A fifth regulation has been drafted, reviewed, and adoption is under consideration. All regulations enunciate source or permit requirements for air pollution control.

Regulation I - "to prevent and control air pollution from coal refuse disposal areas" - was adopted on May 29, 1962. This regulation is not relevant to Region VII, which does not include any refuse disposal areas.

Regulation II - "to control air pollution from open burning operations" - was also adopted on May 29, 1962. Applicable to all regions in the Commonwealth, the regulation states that no person shall permit open burning or conduct salvage operations by open burning "... in such a manner as to cause air pollution". Under the definition of air pollution operative at that time, abatement of open burning required proof of injury or unreasonable interference with life or property. Subsequent 1967 amendments provide for the existence of air pollution to be determined by means of a Ringelmann chart.

Regulation III - "for the prevention and control of air pollution by requiring plan approval prior to the construction or modification of combustion units" - was adopted in October, 1962. As amended, the regulation title substitutes for combustion units, "air contamination sources and a permit for the operation of air contamination sources".

The regulation requires publication of engineering guides which were first accepted by the Commission in November, 1962 and later amended in March, 1964. The regulation now applies only to sources of air contamination specified in the Engineering Guide. When first adopted, the regulation provided only for plan approval and not for continuing approval. Under later amendments, approval by means of permits to operate are added, with provision for revocation and suspension.

Regulation IV - "to control local air pollution from sources of particulate or gaseous matter emissions" - was adopted March 15, 1966. For the first time, under this regulation, a means for empirically establishing that an emission constituted air pollution was provided. Limits for particulate matter emissions are incorporated into the regulation; limits for gaseous emissions based upon ambient air quality objectives were to be incorporated into the regulation at some future date. The primary stated purpose of the regulation was "to permit the Commission to bring about control of single or multiple air contamination sources which are creating specific local air pollution problems". Guides for compliance with the regulation and laboratory procedures for "Particulate Size Determination" have also been prepared. The limits presented in the regulation or developed subsequently are all subject to revision by the Commission which may impose more or less stringent limits. The regulation makes no provision for correction or penalties. Moreover, the regulation does not include all contaminants, with no standards for gases provided.

The proposed Regulation V is designed to control such area air pollution with variations in emission regulations depending on the condition of the atmosphere in different air-basins within the Commonwealth. For example, the area around Scranton-Wilkes Barre would not have the same emission regulations as that of Lancaster. Regulation V is proposes to establish a series of air-basins throughout the state (though the entire territory of the state would not be incorporated into air basins, only those with air pollution problems), and deal with determination of and compliance with various emission limits. The State has previously announced identification of ten separate air-basins within Pennsylvania, including one located over the Delaware Valley. However, the geographic boundaries and coordinates of these air-basins are spelled out in Regulation V. This Regulation also provides for an air pollution alert warning system.

The Commonwealth of Pennsylvania adopted ambient air quality criteria on April 25, 1967, under the authority in the basic 1960 legislation to set maximum permissible quantities of air contaminants. The criteria include air-basin averages for particulates, and single point measurements for ten pollutants: particulates (suspended and settled), lead, beryllium, sulfates, fluorides, sulfur dioxide, oxidants, hydrogen sulfide, and carbon monoxide. Sulfur dioxide, the only pollutant for which three single point measures are provided, lists values of 0.05 parts-per-million for a 30 day period, 0.25 for a single day, and 0.5 for a one-hour period. These values represent minimum, not necessarily desirable quality, yet they are regarded as goals which may not be immediately obtainable. The purposes of the criteria are to assist the Department and Commission to evaluate community air pollution studies, to determine the need for control regulations in various regions of the Commonwealth, and to develop rules and regulations. The criteria are not themselves rules or regulations and therefore cannot be used as a legal enforcement device. Subsequent development of the criteria will be in conjunction with the regulation to control area and air-basin pollution. A Council of Technical Advisors was appointed to periodically review the criteria. Technically, the criteria are an important and progressive development of the Pennsylvania program.

c. Abatement and Enforcement Activities

Under the 1968 amendments, citizen complaints are received by the regional offices of the Department (Region VII, in the case of the Philadelphia area). The regional office investigates the complaint, and makes a recommendation for disposition to the Regional Association. Investigations can require one day to several months, depending primarily on the technological complexity of the source emission. The Regional Association attempts to resolve the complaint by conciliation and cooperation. Within two months of receipt, the Association must refer the matter to the Department for final disposition. The Department may issue orders or institute judicial proceedings if the complaints have not been resolved. Appeals from these orders are to the Commission.

Evaluation of the abatement system is extremely difficult due to the general lack of data. The Air Pollution Control Engineer for Region VII made a complete review of records early in 1968 and these provide the only data available on the operations of Region VII since its inception in May, 1962.

Table 5

Registered Complaint Cases in Region VII
May, 1962 to April, 1968

County	Number of cases	Abated by Association	Abated by Commission	Pending
Bucks	81	40	19	22
Chester	39	22	7	10
Delaware	103	64	18	21
Montgomery	99	47	32	20
TOTAL	322	173	76	73

The cases listed as abated were either declared abated, resolved, or determined to be no problem. These figures suggest a limited use of the complaint system. The figures presented cover a six-year period, in a four-county region having, according to 1960 Census figures, a population of over one and a half million people. No information was available on the type of cases (that is, classification using the industrial code), the average time required for abatement in these cases, or the present disposition of pending cases. The few complaints relative to the size of the region, and the magnitude of the air pollution problem known to exist in this region, negates the validity of an enforcement system based on complaints.

d. Community Air Surveys and Sampling

These surveys are designed to provide the Commission and Department with the basis for regulations as well as to provide local units with needed technical assistance. The surveys undertaken to date emphasize regulations and promoting local programs. Limitations of the Division's manpower and technical equipment are major constraints on the number of these critical examinations of the nature, extent, and effect of air pollution in a given geographical area. The 1960 Act requires such surveys and departmental studies before regulations for the various Regions of the state can be promulgated.

e. Permit Review and Evaluation

Permit systems in air pollution are essentially a tool of prevention. In the Pennsylvania program, such permit systems constitute the only preventive sub-program. These permit systems are operated under Regulations I and II, relating to coal refuse disposal areas and air contamination sources. Permits are required for the construction of any new contaminant source or modification of any existing source. Applications for permits are evaluated as to conformance with the engineering guides required for each of these regulations. Even though the permit system applies only to new or altered construction, gaining information on the particular or contaminant sources for which permits are required is a difficult and critical problem. There are indications that the existing program does not cover all of the new and altered contaminant source construction and building. Again the interaction of manpower shortages and the necessary emphasis within the Department on abatement efforts makes sustained progress in a permit system difficult to achieve.

f. Departmental Resources - Fiscal and Manpower

Appraisal of annual expenditures for the air pollution function is difficult because of the separation of expenditures for regional services from those of the Division of Air Pollution, and the combining of the Division's expenditures with those of the Bureau of Environmental Health. In addition, financial data have been accumulated systematically only in recent years. The following figures represent fiscal estimates prepared by the Division of Air Pollution Control; the manpower figures come from the same source.

Table 6

Estimated Total Expenditure and Number of Employees
Pennsylvania Division of Air Pollution Control
1960-1968

Year	Total	Expenditures Non-Federal	Federal	Employees
1960	Not available			6
1961	Not available			14
1962	$120,000	$120,000		19
1963	185,000	162,487	$ 22,513	23
1964	265,000	169,770	95,230	25
1965	305,000	254,000	51,000	42
1966	405,000	309,000	96,000	47
1967	490,000	354,000	136,000	46
1968	464,697	372,661	92,036	47

Of the total expenditures for 1968, $161,891 was spent for the operation of the regional offices.

Over the past three years the primary program expenditure has been for personnel which has accounted for approximately 80-85% of outlay. Federal funds received in the amount of $699,222 for 1968-9 will permit a greater percentage to be directed to monitoring and sampling equipment.

g. Summary of the Pennsylvania Program

An early conclusion of this study delivered at the 1967 Governor's Conference on Air Pollution described the Pennsylvania control program as "operating at a primitive level." Without diminishing past efforts or discounting the improvements represented in the 1968 amendments to the basic air pollution law, that early judgment is reaffirmed. Pennsylvania's program was initiated in crisis 20 years ago. In the light of that time span, limitations in the legal base, and the general organizational and enforcement pattern of the present program raise serious questions as to whether the Commonwealth has yet committed itself fully to providing the resources required to insure a safe, healthful atmosphere. The seriousness of the problem in this Region is a measure of the degree of commitment and progress required to meet the imperative goal of clean air. Lack of manpower and fiscal resources, a control policy geared to conciliation and cooperation, excessive procedural requirements, enforcement power centered in an administrative commission, an abatement process which relied heavily on citizens' complaints screened through cumbersome local Regional Associations are the primary factors which hamper the operation and growth of an effective program.

An air pollution control matter not yet reflected in the Pennsylvania program concerns automotive emissions. Given the dimensions of motor vehicle pollution established by this study, state action on development of regulations and an inspection program for motor vehicle emission control devices is imperative. Federal statutes require the installation of such devices as part of the manufacturing process. Inspection for adequate maintenance and performance of the devices must be undertaken by the various states. Pennsylvania should undertake such a program immediately. New Jersey has developed a program in this area which could be used as a model.

Statutory and administrative changes in recent years provide a basis for improvements in the Pennsylvania program. The full implementation of these changes accompanied by legislative and administrative actions to correct the defects noted is clearly required.

2. The New Jersey State Air Pollution Control Program

a. Background and Organization

New Jersey's air pollution program was one of the first state programs to be initiated, both nationally and in the Penjerdel Region. The basic air pollution control statute was enacted in 1954. This early act was substantially revised with the passage in 1967 of a series of strong control measures leading to departmental reorganization, program development, and increased fiscal and manpower resources. The New Jersey program is now emerging as one of the strongest state air pollution programs in the nation. Political commitment to the development of a viable air resource management and control system is evident in the New Jersey legislation.

The impetus to air pollution regulation in New Jersey was much the same as that in Pennsylvania. As the result of general public complaints, an informal program was established in the Bureau of Industrial Hygiene of the State Department of Health during the 1940's. The Donora, Pennsylvania, disaster of 1948 led to development in 1950 of a formal air sanitation program under the Department's Bureau of Adult and Occupational Health. The continuing seriousness of air pollution, particularly in the urban-industrial complex of northern New Jersey, led to the 1954 enactment. The 1967 revision involved four separate bills completely revamping the air pollution program's organization, emergency powers, permit system, and sanctions.

During the thirteen year period of 1954-1967 only minimal advances were made toward air pollution regulation. As in the basic Pennsylvania legislation, an Air Pollution Control Commission was established with authority to promulgate standards. The Commission was composed of 9 members: 3 state commissioners, ex officio; 5 members nominated by a panel of industrial and professional organizations; and one member from the public at large. Conciliation, persuasion, and negotiation were at the center of the Act, and it was not until 1962 that an enforcement process was incorporated into the law. Prior to 1962 only one court conviction was obtained in eight years. Through 1967 an extremely limited number of standards were adopted.

The Air Pollution Control Commission under the 1954 Act was assisted in rule-making and regulation promulgation by county air pollution associations, technical committees, and advisory committees. The Commission had additional responsibility for supervision of research programs and conduct of hearings in addition to the rule-making function. The air sanitation program which embraced laboratory services, enforcement, research and development, and education was under a Division of Environmental Health within the State Department of Health. County commissions, where existent, reviewed codes and regulations of "strictly local application" and made studies. Operation of the air sanitation program was hampered by this separation of rule-making, enforcement, research and hearing functions among these various agencies.

The reorganization which followed the 1967 amendment to the 1954 basic statute combined overall waste management considerations and air pollution functions. The newly created Division of Clean Air and Water embraces all major environmental concerns with water pollution, air pollution, and solid waste disposal operating programs and advisory councils, all under the Department of Health. The Air Pollution Control Commission and the county control commissions were abolished, with their functions transferred to the Department of Health. Thus all major functions associated with air resource management were brought under the unified direction of a single responsible operating agency. A Clean Air Council was created as an advisory agency. The Council was appointed by the Governor during July of 1968. Under the 1967 amendments the Council studies the total program, particularly codes, rules, and regulations; investigates technical control issues; and holds annual hearings concerning these and related questions.

The reorganization also created regional offices with primary responsibility for servicing air pollution control needs of specified counties. Three of the New Jersey counties within the 11 county area of this study (Camden, Gloucester, and Salem) are included within the Southern District Field Office, while Burlington and Mercer are under a regional office operating out of Trenton. In general the regional offices are field offices for the total air pollution program and do not have a separate administrative identity as with the Pennsylvania program. Processing of air pollution complaints, provision of emergency services, and closer source surveillance through familiarity, accessibility, and proximity with the counties of the region are the mission of the regional offices.

b. Air Pollution Regulations

The basic abatement strategy pursued by New Jersey has been toward development and enforcement of emission regulations. New Jersey has not developed ambient air quality criteria or standards. The State's position appears to be that it is the responsibility of the Federal government to develop air quality criteria and standards, since the states are too limited in research and technical capacity to be capable of developing fully acceptable criteria and standards. The New Jersey view is that state research capacity and related efforts should be directed toward development of technically meaningful emissions regulations. Thus, codes and regulations are the vital element in the New Jersey enforcement system.

The first eight "Chapters" of the New Jersey regulations were adopted during the existence of the Air Pollution Commission. Subsequent Chapters were promulgated by the Department of Health after the 1967 reorganization. The basic provisions of the regulations are summarized below.

Chapter I, which is entirely procedural, set forth in 1956 several definitions used in other parts of the Air Pollution Control Code. Trade waste, open burning, salvage operations, person, and air pollution were some of the terms defined. The definition of air pollution was changed by the 1967 amendments.

Chapter II, the first of the regulatory regulations, prohibits open burning and the creation of air pollution from refuse disposal and salvage operations. The State of New Jersey now looks to the local governments for assistance in the regulation of open burning. Guidelines for local government ordinances issued in late 1967 include control of air pollution from open burning as an appropriate provision for local regulation.

Chapter III allows for municipal air pollution ordinances or regulations not inconsistent with the State Code. As indicated in the analysis of New Jersey laws, this regulation resulted in considerable litigation as to the meaning of the term "inconsistent". The 1967 amendments and the "Guidelines for Local Ordinances" issued by the Department of Health have resolved this issue, by specifying the nature of local activities.

Chapter IV regulates the density of smoke emissions using the Ringelmann chart as the standard. This regulation requires direct observation of actual violations by a trained staff of considerable size. The control of smoke and other visible emissions from fuel burning equipment are included as a proper element of local regulatory efforts.

Chapter V provides rules governing the emission of flyash as a result of the combustion of solid fuels. This provision of the State Code was later revised to provide more stringent standards for new installations and to require provision of sampling and testing facilities, upon the request of the Department. Enforcement of this regulation, however, requires stack sampling and only since 1967 has the required equipment and staff been available to accomplish such tests.

Chapter VI is a general prohibition against air pollution from other than sources specifically regulated. It excludes, however, "economic poisons" (defined as insecticides, herbicides and other defoliants). Because of a lack of emission standards for such a general category of emission sources, this chapter added little armament to the state's enforcement machinery.

Chapter VII, a Commission regulation adopted in October, 1964, provides rules for control of the emissions of solid particulates from stacks and chimneys. This regulation contains elaborate performance standards directed primarily at single point sources of significant levels of pollution; concepts such as stack height, distance from the stack to the nearest property line, plume rise, and the toxological significance and effect of specified chemical elements were defined. Despite the enforcement limitations implicit in the concepts of stack height and distance to property lines, the Chapter nevertheless has proved to be useful in the control of industrial emissions, particularly foundries and concrete plants. The Supreme Court of New Jersey sustained administrative orders issued by the Department under this regulation.

Chapter VIII, the last of the regulations to issue from the Commission, deals with sulfur dioxide emissions from industrial sources and provides an enforcement framework for control of other chemical emissions. The allowable emission for sulfur compounds in the form of gases, vapors, or liquid particulates is computed in terms of stack heights and ground level concentrations. But a ceiling on stack concentrations is imposed which recognizes the total effect on the ambient atmosphere. Standards are in terms of gas concentrations permitted and hourly and instantaneous discharge quantities. The Code requires industrial record keeping. The Chapter has added importance because the system of enforcement prescribed can be replicated for other gases and vapors.

Chapter IX emanated from the 1967 statutory amendments which provided for a permit system under which all plans related to air pollution control equipment required Department of Health approval. This chapter sets forth the procedural requirements in obtaining permits to construct, install and alter, and certificates to operate control apparatus or equipment, and indicates the equipment categories for which a permit is required. Possession of a certificate to operate does not remove the requirement to conform and comply with other provisions of the State Code. Approved equipment must incorporate advances in the "art of air pollution control developed for the kind and amount of air contaminant emitted by the applicant's equipment."

Chapter X and Chapter X-A regulate sulfur dioxide emissions caused by the combustion of fuels. Chapter X relates solely to sulfur emissions caused by the combustion of fuel oil; the effective date of this regulation was May 1, 1968. This Chapter provides for a three-stage progressive reduction in the sulfur content of fuel oil.

Perhaps the most significant aspect of both Chapters X and X-A from the point of view of developing effective controls to prevent air pollution is that they restrict the sale of fuels which exceed the stated sulfur contents. The language of Regulation X is specific, as follows: "On and after the effective dates listed therein no fuel merchant shall store, offer for sale, sell, deliver for use or exchange in trade, for use in New Jersey, and no person shall use commercial fuel oils which contain sulfur in excess of the percentages by weight set forth in the following table," (emphasis added). The table then lists sulfur percentages which provide for a three-stage progressive reduction in the sulfur content of fuel oil over a more than four year period ending October, 1971. By that time, the sulfur content must be reduced to 0. 3 percent for heavier grades of oil and 0. 2 percent for lighter grades. Fuel oils containing a higher percentage of sulfur are permitted if the excess sulfur dioxide is removed from the flue gases. Similar provisions are provided restricting the sale or use of high sulfur coal in Regulation X-A. Seven rural counties of southern New Jersey are excluded from application of stages 2 and 3 standards because they do not have great amounts of sulfur dioxide in their atmosphere.

The significance of the regulation from a control point of view is that it is highly enforceable and gives assurance of the prevention of air pollution.

Chapter X-A supplements the provisions for sulfur control from oil combustion with provisions on emissions from coal combustion. Promulgation of the regulation was delayed to permit the investigation of available technology in equipment for removing sulfur dioxide from flue gases in coal burning operations. Under a two-stage reduction process, the regulation provides that, after October 1, 1971, neither bituminous nor anthracite having more than 0.2 percent sulfur may be sold retail in New Jersey. Again the seven rural counties are exempted from the second stage.

The New Jersey regulations of sulfur content within coal and oil are characterized as the first statewide measures of this type in the nation. The detailed and extensive technical materials which accompany the regulations provide the basis for the codes. Even more significant accompanying materials acknowledge the cost of compliance in terms of fuels costs, equipment conversion, process alterations, and other "economic dislocations." Regulation X-A is now being tested in suits brought by E. I. duPont Company, representatives of the coal industry, and railroad companies challenging the constitutionality of these provisions. Full implementation of Regulation X-A has been delayed pending the result of this court action. The ultimate effect of Chapters X and X-A in the northern metropolitan area has been estimated at a 70 percent reduction in sulfur dioxide emissions from domestic space heating and power generating plants, 87 percent of sulfur emissions from commercial space heating, and 83 percent reduction in such industrial emissions.

Chapter XI, for controlling air pollution from incinerators, was issued on June 12, 1968, and became effective on August 15th, 1968. All types of incinerators - municipal, industrial, commercial, and residential - are regulated under this ordinance. Emission standards applied by this performance standard code are extremely strict. Particulate emission standards for "common" and "special" incinerators are effective for new incinerators in 1968 and for all incinerators as of August 15, 1970. The Regulation establishes a new smoke density standard for incinerators which is twice as stringent as the existing smoke regulation (Ringelmann No. 1) and incorporates an opacity standard.

Future Regulations. New Jersey presently contemplates the issuance of regulations dealing with air pollution emergencies, providing standards for smoke emissions by diesel vehicles, regulating soluble fluorides, and, most significantly, setting standards and providing for enforcement concerning hydrocarbon and carbon monoxide emissions from automobiles. Emission standards are also being developed for phenol, nitrogen compounds, and chlorine compounds. While the schedule for issuance of these regulations is not firm, within a year most if not all should be part of the

New Jersey program. In addition, revisions to four existing code chapters are planned.

c. Emergency Control and Air Quality Monitoring Network

Over the past several years the State has been proceeding with development of a monitoring network to furnish data for an emergency early warning system and to provide information on existing air quality and improvements, both long and short term, resulting from the control program. As of early 1968, this system included a central station at Trenton, major air monitoring stations at Camden, Hackensack, Paterson, and Perth Amboy, air monitoring laboratories at Ancora, Bayonne, and Newark, all providing continuous measurement from close to 100 testing devices and 22 air monitoring stations distributed around the State. Sulfur dioxide, carbon monoxide, and smoke are the major pollutants continuously monitored. A total of ten important air contaminants will be observed. Another network for sampling suspended particulate matter is under development. The system is expected to be fully operational before the end of 1968 and will provide both a warning system and an air quality management network.

d. Motor Vehicle Air Pollution Control

Under New Jersey law the Department is responsible for developing standards for control of motor vehicle air pollution. Test equipment and procedures have been developed for use in New Jersey's annual motor vehicle inspection system. This was the first of a five-phase program, with the second phase involving determination of baselines resulting from surveys of representative samples of autos. The testing system will not be ready for operation until the fall of 1969 at the earliest. Clearly New Jersey and California are the only states to take steps to augment the Federal standards, applicable to newly manufactured automobiles, with an enforcement program designed to assure that new cars continue to meet, and older automobiles already in use conform to reasonable emission standards of performance. It is imperative that all states within the Penjerdel Region implement a similar program of auto emissions control.

e. Enforcement of Regulations

The enforcement procedure provided in the basic 1954 statute (as amended) was not changed by the 1967 alterations in the law; that is, the procedure involving issuance of orders, hearings associated with the issuance of orders where there are no emission limits, time allowed for corrective action, hearings for persons aggrieved by orders, use of sanctions, and recourse to legal action was not changed.

Under the 1967 amendments, however, the Department of Health now administers the enforcement procedure; penalties are now set at a maximum of $2,500 a day with provision for rebate up to 90 percent of the penalty. Augmented enforcement activities made possible under the 1967 amendments are reflected in the following report covering 1967 made by the Director of the Division of Clean Air and Water. "Last year almost 500 air pollution orders were issued, most of them against sources contributing one form or another of particulates into the atmosphere. More than 200 enforcement conferences were held; more than 30 formal administrative hearings were held; and 136 cases were the subject of penalty actions of Superior Court injunctive proceedings. More than $21,000 in penalties was imposed. More than 2,500 cases were closed out by compliance in one manner or another." This record includes significant judicial victories in contests with major industrial polluters, resulting in consent injunctive orders, consent arrangements, and levying of substantial fines.

Prior to 1962, under an advisory conference-oriented industrial hygiene program, prosecution was procedurally most difficult; only one such prosecution was successful prior to 1962. Amendments passed in 1962 provided the present enforcement authority, but the resources for its operation only began to be available in 1966. As indicated above, only in 1967 has the transition to formal hearings, injunctive proceedings, and substantial penalties demonstrated a new enforcement philosophy in the New Jersey program.

f. Departmental Resources

When the first New Jersey air pollution statute was passed in 1954 the air pollution control operation had a budget of $24,000 to support a full-time staff of three. In fiscal year (FY) 1958-59, the last year of solely state financing, the program received $91,000 with a personnel contingent of less than ten. Federal funds of roughly $6,000 were provided in the three years 1959-61, with a total appropriation of $112,000 in FY 1961. Subsequent growth in funding available for the air pollution control program is shown in Table 7 below.

Table 7

New Jersey Air Pollution Control Funds
1962-1969

Fiscal Year	State Funds	Federal Funds	Total
1962-63	$114,500	$ 31,200	$ 145,700
1963-64	137,600	38,900	176,500
1964-65	284,600	125,400	410,000
1965-66	289,700	250,000	539,700
1966-67	509,000	485,000	994,000
1967-68	843,000	305,000	1,148,000
1968-69	941,000	1,120,000	2,061,000

Source: N. J. Department of Health

Authorized personnel in the air pollution program in 1965 was 21. During the past three years the authorized number was greatly increased, reaching a total of 150 at present. The actual staff complement has varied during the period depending upon the availability of personnel and appropriations. However, the present staff is about five times as large as in 1964-65. The present staffing and funding pattern clearly indicates the substantial commitment New Jersey has made in developing its air pollution control program.

3. The Delaware State Air Pollution Control Program

a. Background and Organization

The Delaware Air Pollution Control program is of recent origin and is presently still in the early stages of development. Development and promulgation of a series of regulations which became effective February 1, 1968 have been the primary work of the Air Pollution Control Division of the Delaware Water and Air Resources Commission which was established in July, 1966. Staff recruitment and program development are not yet complete. Prior to 1966 air pollution control was under an authority within the State Board of Health.

The basic pattern of the Delaware program, as described in the previous analysis of the basic Delaware statute, is summarized as follows:

(1) Air pollution control programs are presently established under state law dealing with conservation rather than health.

(2) The Commission established under the 1966 statute, as its title suggests, has jurisdiction over both water and air resources.

(3) Certain enforcement problems are inherent in the placement of air pollution control activities within an agency for both water and air management. Emphasis on conferences, cooperative programs, and voluntary procedures, while appropriate in some aspects of water resource planning, may hamper air pollution enforcement. In addition, expertise and staff competencies required are quite different.

(4) The Commission possesses legislative, quasi-judicial, and administrative powers.

Under the Delaware Water and Air Resources Commission, four divisions were initially organized relating to water pollution, water resources and subaqueous lands, air pollution, and laboratory divisions. This organization into separate divisions occurred in October, 1966, and the activities of the Air Pollution Control Division were launched in late 1966 and early 1967. There have been no major reorganizations since that time.

The Delaware law does not mention an air pollution division so there is no organizational division of labor set forth between the Commission and the Division as provided in the Pennsylvania law. All powers and duties with relation to air pollution are powers and duties of the Commission, with provision being made in the Delaware law (55 Delaware Laws of 1966, Chapter 442) only for an Executive Director. The Air Pollution Control Director is under the direction of the Commission's Executive Director.

The powers of the Commission with relation to air pollution include responsibility for:

(1) development of a comprehensive program for prevention and control of all sources of pollution in Delaware;

(2) consultation and cooperation with other political and corporate agencies, to include receipt of money for the study of pollution problems;

(3) preparation of studies and promulgation of information concerning air pollution;

(4) promulgation of rules and regulations and the issuance of orders consistent with hearing requirements, and including regulation of installation of new equipment;

(5) consideration of complaints, making investigations, and holding necessary hearings;

(6) undertaking action through injunctive relief and summary proceedings;

(7) requiring submission of plans for removal of air contaminants;

(8) enforcing compliance with the laws of the state relating to air pollution.

As indicated in the discussion of the Delaware statute, a great number of powers are set forth, though in extremely sparse language. A significant constraint is placed on the Commission in a lengthy final paragraph to Section 6203 (Subchapter I, Chapter 62, Chapter 442) dealing with powers of the Commission: "In exercising the powers conferred by this section, the Commission shall give due recognition to the fact that the quantity or characteristics of air contaminants or the duration of their presence in the atmosphere, which may cause air pollution in one area of the State, may cause less air pollution or not cause any air pollution in another area of the State and the Commission shall take into consideration. . . such factors . . . as existing physical conditions, zoning classifications, topography and prevailing wind directions and speeds, and also the fact that a rule or regulation and the degree of conformance therewith which may be proper to an essentially residential area of the State may not be proper as to a highly developed industrial area of the State." The reservations explicit and implicit in such a provision limit the powers of the Commission and tend to suggest that all regulations must be framed in terms of special local area problems.

The air pollution control program came into existence with the establishment of the Air Pollution Control Division in October, 1966. Early directions of the Delaware program, as outlined in the first annual report of the Commission for 1966-67, included: (1) the development of control regulations for particulate emissions, sulfur dioxide emission, and establishment of air quality standards, (2) an initial emissions survey by means of mail questionnaire to develop data on the characteristics of sources, (3) establishment, over a three-year period, of an air monitoring system to measure the quality of air throughout the state, with particular emphasis on the Wilmington area, and, (4) a limited abatement and complaint operation.

The major air pollution problem of the State was viewed as being centered on Wilmington. There are some indications that the State has encouraged Wilmington to develop an air pollution program. However, the State has not developed guidelines for local programs, and no Wilmington program was in existence as of July, 1968.

b. Air Pollution Regulation

"Regulations Governing the Control of Air Pollution" were adopted January 10, 1968, and became effective February 1, 1968. Eight regulations were enacted. The Statement of Policy accompanying the regulations restated the basic constraints on the state-wide applicability of the regulations and the power of the Commission, as specified in Section 6203, previously quoted. In addition, the regulations stated that any person is permitted to apply and receive a Commission hearing on whether his actions contribute to air pollution.

Regulation I sets forth a series of 62 definitions and five administrative principles. Air pollution is defined in terms of producing injury, or unreasonable interference with the "... enjoyment of life and property within the jurisdiction of the State of Delaware, excluding all aspects of employer-employee relationships as to health and safety hazards." The administrative principles indicate that air quality standards established by the Commission will be the paramount control measure, that these standards will be supplemented with emission requirements, and that classifications (rural, industrial, residential) are to be defined on the basis of predominant land use and not the existing zoning system.

Regulation II presents "Requirements for Reports and Certificates of Approval". Both existing and new air contaminant sources are included in the regulation, though the focus is on potential sources. With reference to existing and new sources, the regulation states that the Commission may require any person operating or intending to operate an air contaminant source to submit a report on the operation, as specified in the regulation. Favorable consideration of the report results in issuance of a Certificate of Approval; continued operation without such Certificate is a violation of the regulation.

Regulation III sets forth the conditions under which the State of Delaware will abate sources having an interstate air pollution potential. The most significant provision of this regulation indicates that Delaware will attempt to control existing sources with interstate air pollution potential only if the receptor state has a similar measure, has adopted and is enforcing ambient air quality criteria, and demonstrates to the satisfaction of the Delaware Commission that a Delaware source is affecting such criteria.

Regulation IV relates to the control of a variety of disposal and salvage operations. Individual sections of the regulation deal with open burning, existing incinerators, new incinerators and dumps or sanitary landfills. Under Section 1, limitations on open burning are tied to land use and the areas where open burning is not permitted are specified; exclusions from the provisions are also detailed. Incinerator requirements are stated in limitations on particulate emissions, Ringelmann chart limits, and odor conditions, and vary depending on land use and whether the incinerator is new or operating. Approval for continued and initial operation of dumps is also required.

Regulation V controls smoke emissions from fuel burning equipment. Variations in Ringelmann requirements are established depending on new and existing installations and the land use of the area in which they are located. Installation of photoelectric or other smoke detector can be required.

Regulation VI sets forth ambient air quality standards for suspended particulates and sulfur dioxide. Total suspended particulates and concentrations of sulfur dioxide measured "in the atmosphere at any point outside a source property line which, on an annual basis, exceed the frequency distribution specified below shall constitute a condition of air pollution" (emphasis added). For suspended particulates, twenty-four hour average concentrations for each of four land use classifications are stated along with a single one-hour measurement limit. For sulfur dioxide, one and twenty-four hour average concentrations are also set forth for each of the four land uses. As established, these standards constitute long-range ambient air quality goals and not operational limits.

Regulation VII sets standards for particulate emissions from fuel burning equipment.

Regulation VIII provides standards for sulfur dioxide emissions. Both Regulations VII and VIII require stack sampling and monitoring at the request of the Commission.

c. Department Resources

Analysis of Delaware's fiscal and manpower resources for air pollution is difficult because of the number of activities grouped within the Delaware Water and Air Resources Commission. In general, water pollution and water resource management activities have received the greater proportion of the Commission's resources. Delaware officials indicated that in fiscal year 1966-67, $26, 000 was appropriated and $16, 000 was spent on air pollution activities. Of total Commission funds of approximately $350, 000 for fiscal year 1967-68, roughly $235, 000 went to water resources and pollution control, with air pollution and laboratory services sharing the residual. No Federal funds have been provided for the Delaware air pollution program at any time since its inception.

In August, 1967, the full-time staff consisted of a Division Director, secretary, and part-time field investigators as required. In the past year, staff expansion has occurred, reaching a current level of approximately five full-time staff members. Fiscal resources currently available are reported to slightly exceed $100, 000.

d. Summary

The air pollution control program of the State of Delaware is still emerging, with much basic planning, data gathering, and staffing yet to be accomplished. Basic regulations and ambient air quality standards have been enacted but the program is not fully operational. Emissions and meteorological data are still being developed and an air monitoring network is yet to be completed. Enforcement activities have been extremely limited, centering on particulate emissions in the Wilmington area.

Delaware officials view the Wilmington area as being the only major air pollution problem within the State. The basic pattern of the program that Delaware is developing is a State-directed program which is not heavily involved in the problems of other regional jurisdictions. The emphasis is on creating regulations to meet special local area problems. There is at present little emphasis on dealing with the problems of motor vehicle emissions.

4. The City of Philadelphia's Air Pollution Control Program

a. Legal base

The Philadelphia Home Rule Charter, adopted in 1951, and the Air Pollution Control Ordinance enacted in 1954 provide the legal authority and determine the basic administrative pattern of the Philadelphia air pollution control program. The Charter created the Air Pollution Control Board as a departmental board in the Department of Public Health. The Board is composed of the Health Commissioner and seven members appointed by the Mayor. The appointed members are required to include a business executive, two resident householders and one member representing each of the following fields of activity: (1) operation of plants with high pressure boilers, (2) operation of mining or manufacture of solid, liquid or gaseous fuels, (3) operation of transportation facilities, and (4) a designer of power and industrial equipment. Under the Charter (Section 5-302) the Board is required to "... advise the Department of Public Health and the Board of Health on all matters pertaining to the control of air pollution and shall make reasonable regulations, not contrary to any statute or ordinance or to the regulation of the Board of Health, controlling air pollution."

The Charter also defines responsibilities of the Department of Public Health in air pollution matters as follows: "It (the Department) shall administer and enforce activities, ordinances and regulations relating to public health, including those dealing with air, water, food and drugs, health hazards, the pursuit of occupations affecting the public health, and pests including animal, insect and plant-life." (Section 5-300). The Board of Health, also a Departmental Board created by the Charter, has related powers including the development of a comprehensive Health Code, and the power to "make reasonable regulations" which shall be the regulations of the Department of Public Health.

The 1954 Air Pollution Control Ordinance reflects and implements the basic distinctions in authority and responsibility set in the Home Rule Charter. Section 3-304 (1) of the Ordinance states that the Air Pollution

Control Board has the power and duty to:

(1) "make regulations, to promote the health and welfare of the citizens of Philadelphia, to implement the purposes of this Title, and to prevent and control air pollution and air pollution nuisance;"

(2) "hear and review... any objection to any action or decision of the Department of Public Health..."'

(3) "recommend a program for installation so as to allow a reasonable time for the completion of the installation, if a major installation is required to correct a violation of this Title."

Responsibilities assigned by the Ordinance to the Department of Public Health include:

(1) complaint investigation; observation and correction of smoke and other air pollution conditions;

(2) examination and processing of plans for, and subsequent inspection of installations or equipment that contribute to air pollution, in conjunction with the Department of Licenses and Inspections;

(3) enforcing laws and regulations with reference to air pollution;

(4) disseminating information to the public concerning air pollution control to achieve civic cooperation on reducing pollution.

Under existing statutes the Commonwealth of Pennsylvania retains a degree of control over local air pollution control programs, including the Philadelphia program. The Pennsylvania Air Pollution Control Act passed in 1960, as amended in 1966, contains the following provision: "The procedures for the abatement, reduction, prevention and control of air pollution set forth in this act shall not apply to any political subdivisions of the Commonwealth which has an approved air pollution control agency, except in case in which a source or suspected source of air pollution exists in such political subdivision the effects of which extend beyond the boundaries of the political subdivision concerned. In order to insure effective coordination and cooperation, such air pollution control agencies and programs shall be subjected to the approval of the Commission." (Act of 1960, Section 12, as amended; emphasis added.)

The effect of this provision was to recognize the existence and separate operation of the Philadelphia program established under the 1951 Home Rule Charter and the 1954 City Air Pollution Ordinance and to establish the basis for review and approval of the City's program.

Thus, the Home Rule Charter divides responsibility and basic authority for the air pollution control program between the Air Pollution Control Board and the Department of Public Health. The Board is assigned rule-making authority and the Department is charged with the enforcement of "statutes, ordinances and regulations." The 1954 City Air Pollution Code establishes a program reflecting these Charter requirements. This basic division of authority and responsibility for the air pollution control program between the administrative agency and a board strongly representative of the commercial and manufacturing activities to be regulated provides an inherently weak structure for the development of a strong city program. The authority to both determine and enforce regulations for the control of air pollution properly should be assigned to the administrative agency charged with the responsibility of maintaining a clean, healthy atmosphere. The pattern of vesting the rule-making function in a representative board or commission has been rejected in the recent improvements in the New Jersey State program which have been described. The pattern continues as a part of the state level program in Pennsylvania and represents a basic weakness in that program. In a very real sense, these weaknesses in the Philadelphia and Pennsylvania programs complement each other and militate against the development of an effective air pollution control program for the industrial center of the Penjerdel Region. The City is now in the process of developing a new Air Management Code which is expected to be submitted to City Council in the fall of 1968. However, the new Code will not involve proposals to amend the Philadelphia Home Rule Charter to correct this basic defect in the legal base underlying the City's program. A preliminary draft of the new Code now being reviewed continues the division of authority between the Air Pollution Control Board and the Department of Public Health even though the powers of both agencies are expanded and strengthened.

b. Organization

Until quite recently, the major organizational entities of the Philadelphia program were the Air Pollution Control Board and the Air Pollution Control Section under the Community Health Services Division of Environmental Health in the Department of Public Health.

The Air Pollution Control Section is composed of an inspection and enforcement unit, an engineering unit, and receives the services of an environmental health laboratory unit. The enforcement unit undertakes observation of emission sources and related surveillance, complaint response and investigation, follow-up calls on violations for continued compliance, permit compliance checks, and preparation and prosecution of court cases. The engineering unit is responsible for review of plans and specifications, emission inventories, source investigations, industrial surveys, and conduct of related administrative conferences and hearings. The environmental health laboratory provides air monitoring results, source sampling, and instrument calibration and repair.

The Air Pollution Control Section has been designated as an Air Management Services Unit under an Assistant Health Commissioner. This unit will have greater public visibility and an elevated position in the Health Department. Reorganization resulted in part from a Federal study by the National Center for Air Pollution Control completed in June, 1967. Similar to the existing organization, the new air management services unit will have a technical services division, an enforcement division, and an engineering division. The Federal report, "Philadelphia Air Resource Management Program - Suggested Organization" also includes a functional statement for each division and a job description for each division head. This plan has been adopted as the basis for the reorganization of the Philadelphia program.

With respect to the powers and duties of the Air Pollution Control Board, the report states that these were "deemed unchangeable" because they are prescribed by the Home Rule Charter. In examining the changing role of such boards around the country, the Report does state, however, that such Boards should not have the function of determining emission regulations, and that "the amounts and types of emissions that can be allowed without exceeding the (air quality) goals thus become technical matters for the air pollution control agency staff to study and decide."

If the power to make regulations is removed from the Board's jurisdiction, and the power to deal with offending installations is acknowledged to be a technical matter, all that remains of the present power of the Board is the hearing function which the Board is already permitted to delegate to examiners. The review of developments in the air pollution control field afforded in this study supports the general conclusion that all such boards and commissions should perform only advisory functions. This change in powers and duties of the Philadelphia Air Pollution Control Board would require amendments to the Home Rule Charter.

c. Program Performance, Progress, and Prospects

Philadelphia is scheduled to receive substantial amounts of Federal funds, perhaps as much as $2,000,000, over the next three years, and is committed to major changes and improvements in almost all aspects of the existing air pollution control elements. For this reason, the major elements of the existing program will be reviewed in conjunction with the plans and prospects for improvements and alterations.

(1) Code Revision

Deficiencies in the Air Pollution Code and Regulations of the Air Pollution Control Board are generally recognized. Existing codes and Regulations lack even provision for obtaining essential information and data on air pollution matters. There is no specific grant of authority to the Department of Health to undertake air pollution studies. General prohibitions on emissions in the Code are not supported by adequate and specific standards in the Regulations. Emission control standards are limited to smoke, dust, fumes and vapors with densities related to Ringelmann Chart readings, or the obsolete limit not to exceed 0.85 pounds per 1,000 lbs. of gases emitted. The regulations contain no authority for control of emissions of sulfur dioxide, nitrogen dioxide, carbon monoxide or other contaminants ubiquitous in the urban atmosphere. There are no ambient air quality standards in the City's control program. Based on a substantial volume of citizen complaints, new regulations for the control of incinerator emissions were adopted by the Air Pollution Control Board in June, 1968.

Much of the inadequacy of the Philadelphia program is due to lack of revision and essential updating of the Air Pollution Control Code and Regulations. Complaints have resulted in some revision and expansion to control open burning and incinerator emissions. Complaints cannot be relied upon to motivate progress in controlling the noxious and toxic emissions from industrial and transportation sources. The development of such control systems requires a full component of technically qualified staff and sustained commitment of the City administration. The very recent action of the Pennsylvania Air Pollution Control Commission in withdrawing approval of the Philadelphia program was largely based on the failure to correct the inadequacies of the existing Code and Regulations. As indicated, revision of the City's Code and Regulations is now underway. Revisions, when enacted, will extend to provisions covering specific emissions from combustion and process controls.

(2) Enforcement

The enforcement system of the Philadelphia program revolves around detection of violations through either complaints or actual observation and patrolling by inspectors. The patrol system involves the use of 16 radio dispatched vehicles. The enforcement process is not prescribed in the basic law or regulations beyond the powers of the Department of Health to investigate complaints, review plans, and inspect installations, and the Board's power to review actions of the Department.

Under existing regulations, violations are cited by field inspectors. If compliance does not follow and the emission is of considerable magnitude and frequency, several steps may follow, including office conferences and hearings, a more detailed source survey, with precise recommendations for control and a compliance schedule. Recourse to legal actions involves the magistrates' courts, administrative hearings before the Philadelphia Law Department, appearances before the Pollution Control Board or the Licenses and Inspections Board of Review, and finally consent decrees and injunctive actions.

Beginning in 1964, enforcement emphasis turned to the use of the magistrates' courts, where fines of up to $100 may be assessed. Use of the magistrates' courts as an enforcement tool is totally inadequate because of lack of technical competence of the magistrates in making such decisions, inconsistent decisions, and low fines. There is at present an effort to have City Council increase the fine limitations.

The present system of enforcement through fines lacks equity and provides no deterrent to potential and actual polluters. Coupled with a weak code and obsolete, non-specific regulations, the effect is that the Department of Public Health has no effective enforcement and must rely either on cooperative actions by pollution sources or empty threats. Proposals to merely double the maximum fines are not an adequate remedy to the Philadelphia enforcement problem. If a positive deterrent is to be achieved, fines such as the New Jersey levy of $2,500 per day, with each day constituting a separate violation, should be considered. But the more important point is that fines and after-the-fact penalties alone do not make a realistic enforcement system. Other enforcement alternatives which focus on prevention through comprehensive permit and licensure machinery related to equally comprehensive air quality standards and emission regulations are clearly required.

The permit system employed by the City constitutes another element in the enforcement process. Permits of certain types are granted by the Department of Licenses and Inspections. The engineering unit of the Air Pollution Control Section is also involved in the review of plans and specifications for boilers, dust collectors, incinerators, and laundries and dry cleaning establishments. Exempted are fuel burning equipment of less than 250,000 BTU per hour, automobiles, and residential dwellings with less than three dwelling units. Adequate inspection programs have not been developed and the permit system is by no means fully operative.

The following are reported statistics on enforcement compliance, permits, and plan review for the Philadelphia program during 1967:

Total Investigations	5513	Violations Prosecuted	317
Complaints	2831	Violation Convictions	234
Motor Vehicle Citations	3322	Conferences	92
Corrections Required	1985	Permits Issued	288
Corrections Made	1454	Plans Reviewed	87
Violations Issued	637		

(3) Emissions Inventory

During 1967-68 the Air Pollution Control Section made an emissions survey to determine total fuel usage within the City of Philadelphia. The inventory covered transportation, domestic fuel, commercial fuel, fuel for electrical power generation, industrial fuel, industrial processes, and refuse disposal. Utilizing 1966 as the reference year, information was obtained concerning sulfur oxides, nitrogen oxides, organics, carbon monoxide, and particulates. Personal contact and surveys, published data, census data, and questionnaires sent to some 7000 industrial and commercial establishments were all used to provide data. Sulfur emissions were indicated as being of primary concern. The only previous emissions inventory taken since the 1954 inception of the program was done in 1959, using 1957-58 data.

Results of the City's 1967 study showed a decrease in emissions for the four pollutants measured in both surveys. The results obtained by the Drexel emissions inventory for this RCEO study are reasonably close. However, the Drexel data do indicate that sulfur and nitrogen oxide emissions during the decade have increased.

Since sulfur dioxides were the principal concern, the City contracted with the Franklin Institute for additional analysis of the data obtained by the emissions inventory for this pollutant. The Franklin Institute report, "A Study of Sulfur-Dioxide Distribution in Philadelphia During 1967," was completed in June, 1968, indicating that more than 688 tons of sulfur dioxide per day are emitted during "heating months."

(4) Air Monitoring

The principal monitoring facilities now available to the City of Philadelphia include:

- A continuous air monitoring station at the Franklin Institute.
- A continuous air monitoring station at the Environmental Health Laboratory of the Department of Health.
- A mobile air sampling station purchased by the City in mid-1967.
- A series of 12 smaller air sampling sites, units which monitor only particulates and a soiling index.

The two continuous monitoring stations provide data on the amount of sulfur dioxides, nitrogen oxides, carbon monoxide, hydrocarbons, soiling index, and other oxidants in the atmosphere. The mobile air sampling station measures fewer pollutants - sulfur dioxide, carbon monoxide, hydrocarbons and total oxidants. The mobile station also has a weather mast for determining wind velocity and direction.

The absence of information on the quality of the Philadelphia atmosphere has been a hindrance both to the Department of Health and to those who have undertaken various air pollution studies of the Delaware Valley region. Until the last several years adequate air quality data were not available. The Department of Health, with Federal financial support, now plans to add four complete monitoring stations in each of the three fiscal years covered by the present Federal grant. Additional useful air quality data will be produced by the RCEO study, of which this Report is a part, and by the Delaware Valley Regional Air Quality Project now being conducted by the Federal government.

(5) Emergency Alert System

An alert system was developed for Philadelphia in connection with the thermal inversion of Thanksgiving, 1966. Reports on weather conditions, pollutant concentrations, and a classification of industrial sources by emission potential were used. A combined air pollution index based on sulfur dioxide and smoke shade was developed. The system was based on the physical impact and deleterious effect on the exposed population when high concentrations of sulfur dioxide exist in the ambient atmosphere with similarly high concentrations of particulates as measured by smoke shade measurements. Specific defined actions to control emissions were related to the index numbers. Two groups of Philadelphia industries were contacted to seek voluntary reduction of emissions: Group One included the major electric company, two of the largest chemical plants, and two large smelting plants; Group Two included smaller industrial and commercial operations, including chemical and metal smelting plants, automobile scrapyards, and other sources. The system depends entirely upon cooperation. In the 1966 incident, cooperation by industries was reported as excellent.

As previously noted, there is movement toward a regional alert system under the informal Interstate Committee on Air Pollution. Also, a Pennsylvania alert program is being developed in conjunction with a Federal grant that has been made for study of air pollution control emergency systems. This study is a joint effort of the Commonwealth and the City.

d. Departmental Resources - Fiscal and Manpower

The City's commitment to clean air in terms of local tax dollars budgeted over the past three fiscal years has been limited. Projections of expenditures over the next three years are much greater due to expected substantial Federal support. Total budget allocations and projected expenditures, showing the source of funds for each year since 1966, are shown below. The reporting year was the calendar year until 1968 when the fiscal year (July 1 - June 30) plan was adopted.

Table 8

Philadelphia Air Pollution Program Budget Allocations, 1966-1968, and Projected Expenditures, 1968-1971, Showing Source of Funds.

	Year	Local	Federal	Total
Calendar Year:	1966	$264,470	$172,336	$ 436,806
Actual	1967	289,958	223,312	513,270
	1968 (6 mos.)	155,979	111,656	256,635
Fiscal Year:	1968-69	449,335	483,150	932,485
Projected	1969-70	533,062	650,604	1,183,666
	1970-71	551,813	688,105	1,239,918

Source: Philadelphia Department of Public Health.

Staffing has been a continuous and difficult problem for the Philadelphia Air Pollution Control Section, particularly at the top levels. In the last five years, personnel changes in the section chief and assistant chief positions have been frequent. Low salary levels and lack of full commitment required to transform and strengthen the program are apparently major causes of top staff turnover.

As of March 1, 1968, the number of staff positions authorized for the Air Pollution Control Section was 56. The number of persons actually employed in the Air Pollution Control Section on that date was only 38. The current number of staff is approximately the same.

The projected increase in expenditures involves a commitment to greatly increase the present staff. Major increases will be (1) an increase in inspectional forces from 13 to 26, including 12 new inspectors, (2) a similar doubling of professional engineering staff from 8 to 16, and (3) four additional professional engineering and chemical positions in the Environmental Laboratory. If the newly authorized positions can be filled and the recently appointed Assistant Commissioner can provide technical and administrative leadership, the Philadelphia program may overcome the staffing problems of the past five years.

e. Summary

This brief examination of the Philadelphia air pollution control program has outlined future prospects as well as existing and past deficiencies. The major program objectives developed in connection with application for the substantial Federal grants over the next three years should represent a commitment by the City for the radical improvement clearly required. In summary, these goals were designed to overcome the basic and pervasive weaknesses in the program in past years, including:

- an obsolete code which does not support enforcement or prevention efforts;
- the lack of an air monitoring and sampling network to provide valid data on existing air quality;
- an organizational unit which lacked visibility and support within the Department of Health;
- an ineffective enforcement system based largely on complaints instead of positive enforcement actions and on minimal fines levied through the magistrates' courts;
- a lack of up-to-date emissions inventories which provide the basis for regulatory priorities through an understanding of the extent and sources of pollution;
- the absence of a comprehensive emergency alert system based on immediate compulsory actions to achieve emission reductions;
- meager fiscal and manpower resources prior to the advent of Federal grant funds in 1965, and in fact until the major 1968 project grants;
- the lack of both ambient air quality standards and emission standards and regulations for controlling the major urban atmospheric pollutants; and

This list of basic deficiencies which clearly reflects the fact that the City's program has not moved forward nor kept pace with the rapid developments in the air pollution field. Prospects for new directions now seem excellent. Emissions inventory data, meteorological analysis, health effects and related materials developed in the RCEO study should be of assistance. The Delaware Valley Regional Air Quality Project being staffed and financed by the United States Public Health Service will provide further information and technical assistance on emissions, air quality, meteorology, procedures for regulatory approaches, and a long term master plan for air resource management. With this external assistance, the commitment to an internal reorganization under a newly appointed Assistant Commissioner of Health and a well-staffed Air Management Services Unit should produce an effective program and the essential improvements in the air quality of the third-worst polluted metropolitan area in the nation.

5. Local Government Air Pollution Control Activities in the Penjerdel Region

a. Role and Responsibility of Local Government

The existing and potential role of local government in air pollution control varies in accordance with differences in perception of the air pollution problem at the local level and differences in enabling statutes in each of the three state jurisdictional areas within the Penjerdel Region. In general, legislation in each of the states permits the continued existence of any local ordinance and programs operative at the time of passage of the state air pollution control act, and the enactment of new ordinances under certain restrictions. Local standards and regulations may not be less stringent than state standards, and, in New Jersey and Pennsylvania, local ordinances and programs are subject to state approval. Thus, local governments, as creatures of the state, are usually granted permissive and limited powers in air pollution control subject to specific or general state approval. In Pennsylvania, further distinctions are made among the types or classes of local government which may implement this power.

In order to determine the extent, nature, and general effectiveness of local government air pollution control programs outside of Philadelphia, a survey of such activity was conducted as a part of this study. Data on local air pollution control programs were obtained with the active assistance of county planning commissions, the Rutgers University Extension Service, and the air pollution control agencies of the various states. The clear conclusion of the survey is that, regardless of differences in enabling legislation among states, local government programs and activities in air pollution control in the Penjerdel Region are extremely limited in number, scope and effectiveness and are, as of now, of negligible importance viewed in the context of a total regional response. This general finding should not be interpreted as a statement of the ideal or optimum local government role. An effective response to the Region's air pollution problem will require integrated commitment and effort by Federal, state and local jurisdictions. The Federal Department of Health, Education and Welfare and several national agencies including the Air Hygiene Committee of the American Public Health Association (APHA) and the National Association of Counties (NACO) support the above statement and have proposed general guidelines for establishing optimum local government programs in air pollution control. The Air Hygiene Committee of APHA enunciated an ambitious program for local agencies which are not part of a decentralized state program. Program ingredients outlined in the October, 1960, Journal of the American Public Health Association emphasized public information, coordination of preventive and inspectional programs, and financing at a level of from ten to twenty cents per capita.

"Clean Air for Your Community," a publication of the U.S. Public Health Service, presents an ambitious checklist for community air pollution activities and stresses the relationship of air pollution and other "regional" problems with questions concerning trash disposal, the presence of plans for mass transit, land use and open spaces, and coordination of effort with surrounding communities. The implication of the PHS guide is that every community over 50,000 and those with major nuisances in lower population categories should have local abatement programs.

The National Association of Counties, in its "Community Action Guides for Air Pollution Control" specifies the role for local government, particularly counties and cities with a population over a quarter of a million. Such units of local government, according to NACO, should adopt a comprehensive air resource management plan including a broad control ordinance, an aggressive air pollution public information program, elimination of archaic methods of waste disposal, and funding at "an absolute minimum of $.40 per capita...". The air pollution control ordinance should create a permit system, provide for misdemeanor and injunctive powers, and require coordination between the air pollution control agency and other county or municipal agencies.

Counties have been most frequently suggested as the unit of local government appropriate for the development of significant air pollution control activities and as a base for intergovernmental arrangements for such activities. Several justifications have been offered. The county has been variously viewed as the smallest unit capable of dealing effectively with the problem of air pollution. As the basic regional unit of government, it is amenable to an area-wide approach reflecting enforcement authority and inspection capability. The National Association of Counties concludes that the key to an effective regional program is the utilization of county units of government.

In terms of the role that local government, particularly counties, might play in air pollution control, the survey makes clear that local government activities in the Penjerdel Region are quite undeveloped. In the entire 11-county Region, only the City of Trenton and Barrington Township in New Jersey, and Downingtown Borough in Pennsylvania were found to have air pollution control ordinances with some type of program of enforcement. Nineteen other jurisdictions have enacted air pollution control ordinances, but none of these has any enforcement program. A great many municipalities have general restrictions concerning air pollution in their zoning ordinances and fire codes, but such provisions are not enforced on a continuing basis. Certain counties have developed interest in air pollution control activities, but none operates a control program.

The following section contains a brief summary describing the provisions of appropriate statutes under which local programs are operated in each of the three states, and the extent of local air pollution control activity throughout the Region.

b. Local Government Programs in New Jersey

Under the 1967 amendments to New Jersey's Air Pollution Control Act, local ordinances with provisions less stringent than the state statute are invalid. All local ordinances dealing with the subject of air pollution control must be reviewed and approved by the State Department of Health. The Department has recently published "Guidelines for Approval of Local Government Ordinances." The "Guidelines" encourage local governments to control emissions from open burning, small incinerators, space heating equipment and public nuisances. The State Department of Health will assist in the development of local programs by creating model ordinances, by periodic training programs for local officers, and by consultation and coordination activities.

The City of Trenton has an air pollution control ordinance, passed in 1959, which includes open burning restrictions, and smoke prohibitions based on Ringelmann standards. The program operates both on a complaint basis and by continuing surveillance. One sanitary engineer is employed full time to carry out enforcement activities.

Barrington Borough in Camden County adopted in 1966 a sophisticated and comprehensive air pollution control ordinance. A section of the ordinance provides maximum allowable concentrations of major pollutants and trace elements based on health requirements. Under the ordinance, operators of emission sources must provide stack test data showing the composition of their emissions. The program is administered by the Barrington Air Pollution Commission. The Barrington ordinance provides the most comprehensive and stringent local air pollution controls in the Penjerdel Region. It was passed prior to the State act which requires State review and therefore has never been submitted for review and approval. The ordinance is now under court challenge. Another New Jersey municipality, Lawnside Borough, has recently adopted the Barrington ordinance.

The City of Camden is presently considering the adoption of an air pollution control ordinance. The City has a smoke control ordinance passed in 1947 and assigns one sanitary engineer, part time, to air pollution control activities.

Burlington County Board of Freeholders recently appointed a Citizens' Air Pollution Advisory Committee to advise the Board on all matters relating to air pollution. The Committee will concentrate initially on encouraging local jurisdictions to adopt air pollution ordinances and to incorporate relevant portions of appropriate State codes.

Numerous other New Jersey municipalities have ordinances dealing with open burning, industrial smoke and fume control. A few of these municipalities have separate smoke control ordinances, some specifying the use of Ringlemann Chart standards. In most of the municipalities, provisions relating to air pollution are found in the zoning ordinances or fire codes. In all the municipalities other than those specified, enforcement activities are on a complaint basis and do not involve the use of full time air pollution control personnel.

c. Local Government Programs in Pennsylvania

In general, there is more confusion and less latitude in the development of local air pollution control programs in Pennsylvania than exists in New Jersey. The extent of local government powers in air pollution control is defined by both the Air Pollution Control Act of 1960 as amended in 1966, and by the specific grants of power to counties, cities, boroughs, and townships contained in the various codes for those classes of municipalities.

The 1960 Act states: "Nothing in this act shall prevent counties, cities, towns, townships, or boroughs from enacting ordinances with respect to air pollution which will not conflict with the provisions of this act or the rules and regulations promulgated pursuant to its provisions. This act shall not be construed to repeal existing ordinances, resolutions or regulations of the aforementioned political subdivisions existing at the time of the effective date of this act, except as they may conflict with the provisions of this act." A section added in the 1966 amendments provided specifically for State review and approval of local government programs as follows: "The procedures for the abatement, reduction, prevention, and control of air pollution set forth in this act shall not apply to any political subdivision of the Commonwealth which has an approved air pollution control agency, except in the case in which a source or suspected source of air pollution exists in such political subdivision the effects of which extend beyond the boundaries of the political subdivision concerned. In order to insure effective coordination and cooperation, such control agencies and programs shall be subjected to the approval of the Commission."

These provisions might seem to grant permission, subject to state review, to all local governments for the adoption of air pollution control ordinances with broad powers. Their impact is much more limited, however. The section has been interpreted as permitting municipal subdivisions to enact pollution ordinances only if specific authorization is contained in the various codes which establish classes of subdivisions. For example, the various codes applicable to counties of the third to eighth class contain no specific provision authorizing air pollution control activity. Under this limiting interpretation of the enabling provisions granted in the 1960 Air Pollution Control Act, the 63 third to eighth class counties in Pennsylvania, therefore, may not establish air pollution control programs. This interpretation was offered recently when Bucks County sought authority to establish a county air pollution control program. The effort was withdrawn on the basis of an informal ruling by a Deputy Attorney General which stated that, since Bucks County was a county of the third class, it did not have the legal authority to establish the program.

Thus, only four Pennsylvania counties have the latitude to develop control programs. Philadelphia, as a county of the First Class, attains its authority for air pollution control through its Home Rule Charter. Allegheny County, as a County of the Second Class, operates its program based on a limited grant of power added as an amendment to the Second Class County Code. Two other counties, Delaware and Montgomery, located within the Penjerdel Region, were classified in 1967 as counties of the Second Class A and as such are now entitled to develop air pollution control programs.

Similarly, cities of the third class (which exclude only Philadelphia, Pittsburgh and Scranton), boroughs, and first and second class townships, are limited under their respective codes to the enactment of smoke control ordinances. The absence of clear legal authority in state enabling legislation is a significant deterrent in the development of local government programs in Pennsylvania.

Adoption of the new local government article to the Pennsylvania Constitution provides a possibility of overcoming some of the restrictions described. As framed by the 1968 Constitutional Convention, the new article permits municipalities, including counties, to frame and adopt home rule charters. Under the proposed provision, municipalities, "may exercise any power or perform any function not denied by this Constitution, by its home rule charter, or by the General Assembly at any time." A municipality which enacts a home rule charter approved by the General Assembly could undertake air pollution control programs, although subject to review by the State Air Pollution Commission. Another section of the local government article of the proposed Constitution provides municipalities broad authority for intergovernmental cooperation. This section also may be of potential use in developing effective regional air pollution control programs.

Notwithstanding the restraints on local government air pollution control powers, a few municipalities in the Penjerdel Region in Pennsylvania have adopted ordinances broader in some respects than the usual smoke control regulations. Bristol Borough, Montgomery County, East Whiteland Township, and Downingtown Borough, Chester County, Chester City, Delaware County, have such ordinances. The Borough of Downingtown has had an air pollution control officer since the inception of the program in 1966. A number of other jurisdictions, three in Bucks County and eleven in Montgomery County, have separate ordinances dealing with air pollution caused by smoke, dust and fumes. Many municipalities have a general nuisance and smoke prohibition included in their zoning ordinances. Such regulations are not enforced on a continuing basis. It should be noted that although Bucks County was unable to find legal authorization to launch a formal county program, it did establish a Bucks County Air Pollution Advisory Board. The Board has the function of advising the County Commissioners on all aspects of air pollution affecting Bucks County residents. It has developed a model open burning ordinance for local jurisdictions.

In sum, Pennsylvania local government activities in air pollution control in the Penjerdel Region are extremely limited. Existing statutes and policies neither provide clean authorization for a more expanded role nor encourage further development.

d. Local Government Programs in Delaware

Delaware law and regulations do not deal with relations with local governments beyond permitting more stringent ordinances "consistent" with state rules and regulations. There is no requirement for State approval of local programs. There are no local air pollution control programs based on specific local ordinances. Responses from local jurisdictions in New Castle County indicate that these municipalities are content to await development of the State's program before launching any independent program.

The basic legislation on air pollution of the State of Delaware is contained in Chapter 442, Volume 55 of the Laws of Delaware, as amended.

Section 6207 which deals with "Local Regulations" states the following: "Nothing in this chapter shall preclude the right of any governing body of a city or town to adopt local laws, ordinances or regulations which are consistent with this chapter and with rules and regulations adopted hereunder and do not call for a lesser degree of control."

The Delaware Water and Air Resources Commission has adopted regulations pertaining to open burning, incinerators, smoke and particulate emissions from fuel burning equipment, and dumps and sanitary landfills. There is no reference to local enforcement or joint state-local programs. The Commission has the responsibility of enforcing such regulations, with the funding and staffing implications of surveillance and complaint enforcement understood. While local action is not legally exempted, it is, under present regulations, effectively precluded.

In New Castle County, neither the County nor its municipalities have any air pollution control ordinances or programs. The County zoning code contains general use restrictions on emissions of odor, smoke, and fumes. The County also has an ordinance regulating the use of dumps, requiring operation which minimizes smoke and odors and which does not create "a nuisance as defined under the State Air Pollution Law and Regulations." The City of Newark's use regulations for limited manufacturing districts contain smoke density regulations measured by Ringelmann Chart, and prohibitions against open burning and emission of fumes and odors. Both the cities of Newark and Wilmington also have fire prevention codes which peripherally touch air pollution matters. The Law Department of the City of Wilmington indicated that the City is now studying and formulating provisions for ordinances and/or regulations relating to air pollution.

e. Summary and Conclusion

The major findings of this study emphasize the regional nature of the air pollution problem and the necessity of interstate regulatory controls. Local governments should have a role in a total regional response for air pollution control. Federal, regional, and state agencies will continue to suffer from manpower shortages that will make difficult the comprehensive observation and control of all emissions. Emissions which are intermittent - occur at irregular intervals, transitory - occur only for brief periods of time, and the result of simple combustion - requiring no process changes for abatement, are particularly susceptible to local enforcement. For emissions of this type, simple proximity and familiarity with the local community are necessary for effective enforcement. Thus local governments, by adopting local ordinances and providing for their enforcement by trained personnel, can assume an important role in improving total air quality throughout the Penjerdel Region.

SECTION II

EXAMINATION OF AIR POLLUTION CONTROL TECHNOLOGY: THE STATE OF THE ART

A. The Relationship between Control Technology and Public Policy for Air Pollution Control

The appraisal of the existing governmental response to the air pollution problem of the Penjerdel Region indicated the extent to which the instruments of public policy are effective in achieving the objective of insuring a safe, healthy regional atmosphere. Defects and gaps in the jurisdictional, legislative, and organizational base of the present response were illuminated by the analysis. There are also defects and gaps in air pollution control technology which need to be understood in formulating an improved governmental response essential to the development of a regional air resource management and control system. Public policy for effective environmental control, in the final analysis, must rest on technical criteria and standards through which that policy can be applied. Moreover, it is increasingly important that public policy makers and generalist administrators gain evaluative understanding of the highly complex air pollution control technology required for effective planning and control. For these reasons this study of the governmental aspects of air pollution control includes a general appraisal of the state of the art in air pollution control technology.

Control of aerial pollutants involves the entire range of considerations reflected by the major components of this study - emissions inventory, meteorology analysis, health effects, economics, and intergovernmental relations - blended together as a base for a coherent public policy. The expression of this control, however, comes in laws and administrative rules containing standards and guides for enforcement. In the United States to date, the only significant approach to the definition and control of air pollution has come through formulation and enactment of standards and regulations associated with air quality and pollutant emissions.

These standards are expressions of a quantitative relationship between levels of various pollutant concentrations, and their impact in terms of risks for human health and welfare, plants, and property. Standards thus provide a guide for administrative and legal actions, aimed at regulation, under air pollution control programs.[1] A formal definition of standards would be - "quantitative criteria for social and administrative policy-making whose purpose is to guide or restrain individual or group behavior with an assumed benefit to society as a whole."

Though quantitative criteria are an absolute essential for a regulatory program, the technical, social, and scientific bases for these criteria must be continually reexamined. At present, the degree of uncertainty involved in the initial establishment of standards is well recognized, and there are continuing

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[1] Reliance in the following discussion is on Morris A. Shipman, "A Survey of the Use of Standards in the Administration of Environmental Pollution Control Programs," an unpublished dissertation for the Political Science Department of the University of Pennsylvania, 1967.

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efforts to provide sounder scientific evidence on which to base them. Even in the approximately two decades over which present regulations of air pollution have been developed, vast changes in control technology and the appreciation of pollution impact have made previous quantitative measures obsolete.

Governmental agencies and professional-technical organizations that originate standards bear a serious responsibility to establish and make public the premises on which standards are formulated. Once promulgated, standards frequently become generally accepted decisional premises within an environmental specialization and rapidly assume a status of unquestioned validity. It is naive to assume that most of these standards rest solely on technical premises, for the implicit value assumptions that exist in environmental health standards are especially strong. Moreover, the economic analysis component of this study suggests that the public policy decision on standards properly should assess the competing values of cost and benefit to society.

The protection of society from environmental hazards is entirely the responsibility of government, but the dilemma of government is to determine the proper degree of regulation to be reflected in standards and regulations. Insufficient governmental action may expose large segments of our national population to substantial health damage, yet excessive or rigid restrictions might militate against desirable and appropriate industrial development. Since government must determine the quality of environment to be sought, the environment is a focus of public policy. In turn, all governmental jurisdictions in setting environmental policy should seek and act on the best available scientific data while continually reconciling conflicting interests and values.

The basic criterion on which standards are to be based, as emphasized in this study, should be the public health impact. In support of this emphasis, one of the nation's most sophisticated thinkers on public health standards told a Joint Committee of Congress in 1960 that "a criterion must rest upon public health protection and not cost" and that it is not "permissible to kill people to obtain benefits to society."[2] Consistent with this expression, threshold limits should represent conditions that any person can be exposed to day after day without adverse effect, not a hazy line between safe and toxic concentrations based on some conception of a "normal" state of health.

Criticism of standards comes from both community groups and industry - the one condemning any "license to pollute," the other fearing rigidity, over-regulation, and economic cost. The industrial case rests on specific objections such as the indiscriminate borrowing of standards by communities and jurisdictions, failure to delineate objectives which the standards are intended to achieve, and unsound standards resulting from pressures to legislate. The debate on standards is crystalized in the 1966 report of the National Academy of Sciences - National Research Council on "Waste Management and Control." While criticizing standards as a "limited tool of administrative leadership or preventive regulation" often containing "bits and pieces of scientific information, of the professional lore uppermost for a day and of concessions to group and local interest," the report concluded that there was a clear need for an element of public policy represented by standards and that "the issue with respect to standards lies not so much in the concept or use of standards as such, but in how and to what purpose they are used."[3]

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[2] U. S. Congress, Joint Committee on Atomic Energy, Hearings, Radiation Protection Criteria and Standards: Their Basis and Use. 86th Congress, 2nd Session, 1960, p. 12. (Testimony of Abel Wolman)

The conception of standards entertained in this study emphasizes standards employed as a mandatory device with total enforcement potential. As indicated by the survey, only vehicle exhaust emission standards clearly fit a notion of comprehensive enforcement; except for the isolated instances, like New Jersey's fuel standards, standards which are applied comprehensively and with precision are still virtually non-existent.

As previously noted, in the final analysis, the quality of the air in an urban-industrial society depends both on standards and regulations, and on the control technology and instruments to measure and monitor air quality and emissions affecting this quality. This section of the Report consists of a review and examination of source control technology and the issue of standards touching the following questions:

- the extent to which pollutant emissions can be controlled or eliminated through production technologies at the source;
- the comprehensiveness, consistency, adequacy, and stringency of existing ambient air quality standards and emission regulations; and
- the availability and adequacy of monitoring systems for measurement of pollutant concentrations within the atmosphere.

B. Source Control Technology - Methods and Devices

1. Major Sources of Regional Pollutants

As indicated in the emissions inventory conducted by the Drexel Institute of Technology, the six major pollutant categories in the Delaware Valley are (1) transportation emissions, (2) electrical power generation, (3) industrial fuel burning and related process emissions, (4) commercial, institutional, and governmental (CIG) fuel burning, (5) domestic fuel burning, and (6) refuse incineration.

Source control requirements and technology for two of these categories, CIG and domestic fuel burning, are well developed and not particularly complex. Measures for control of the remaining four categories normally involve process changes and thus considerable expense. Yet, once the inevitability of process modifications is recognized, many available control methods may produce by-product advantages in addition to meeting emission reduction requirements.

Emission control requirements for the four major categories can be realized by employing any one or a combination of the following methods: (1) proper maintenance and operation of equipment and processes, (2) substitution or changes in design and materials, (3) modification of processes and related equipment and (4) utilization of control and collection devices to entrap and prevent pollutants from escaping into the atmosphere. Control technology devices include various types of centrifugal and inertial separators, direct fired and catalytic after burners, collectors consisting of electrostatic precipitators, fabric filters, chemical absorbers, and liquid scrubbers.

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[3] National Academy of Sciences - National Research Council, Waste Management and Control, (Washington: National Academy of Sciences - National Research Council, Publication 1400, 1966), pp. 215-6.

The technology employed to control emissions from the six major pollutant sources in the Penjerdel Region is briefly outlined below.

2. Transportation Sources

The primary source of transportation emissions within the Penjerdel area is the automobile which, in 1965, accounted for 97% of such emissions. Moreover motor vehicle emissions accounted for approximately 60% of all air pollution in the Region.

In evaluating present technology there are three points of emission in automobiles - exhaust, crankcase, and carburetor-fuel tank - which account for 60, 30, and 10 percent, respectively, of total vehicular emissions. Hydrocarbons, carbon monoxide, and oxides of nitrogen are the major pollutants emitted. Of the three points of emission of hydrocarbons and carbon monoxide, two are presently regulated by national emission standards. Crankcase emissions have been substantially eliminated through the recycling of blow-by, unburned hydrocarbons, back into the crankcase. These devices were mandatory on all new gasoline powered vehicles in California in 1961, and nationally in 1963. Exhaust control devices, which reduce hydrocarbon and carbon monoxide emissions, were required on all new cars sold in California beginning in 1966. Federal legislation requiring exhaust control devices on all new cars was implemented with the 1968 model year. Standards for evaporative losses from carburetors and fuel tanks will be in effect nationwide by 1970, when more stringent standards for auto exhaust will also be adopted.

California's experience to date indicates that exhaust devices for the control of hydrocarbons and carbon monoxide are controlling seventy percent of the total emissions from the exhaust. Eighty percent control will be required under 1970 standards. Research into catalytic muffler devices and afterburners could provide the means to achieve these future standards. Oxides of nitrogen, a major contributer to the photochemical smog reaction and a potentially severe health hazard, is uncontrolled at the present time. Auto manufacturers are attempting to develop a system designed to reduce all three major contaminants - hydrocarbons, carbon monoxide and nitrogen oxides - with one device. Catalytic devices are being considered since their operation involves reducing combustion temperatures. This prevents formation of oxides of nitrogen which result from high temperature combustion. The emission of lead in auto exhaust is also uncontrolled at present.

Technological change in the nature and design of vehicle power sources is a possible solution to the current emission problem. Development of an electrically powered, battery operated car and a fuel cell are still in an experimental stage. In sum, technological developments to date are not sufficient to alter the enormous quantities of pollutants produced by motor vehicles. The problem of maintaining the auto emission control devices is difficult. Of the three Penjerdel states, only New Jersey has developed a procedure for inspection and maintenance.

3. Industrial Processes

Industrial sources within the Penjerdel Region produce 61 percent of particulate emissions, 44 percent of sulfur dioxides, and 30% of both organic compounds and oxides of nitrogen. The Drexel emissions inventory indicates that 80 percent of the total emissions tonnage in 1965 was produced by six major categories of industrial manufacturers. These categories and the air pollution problems associated with them are outlined in Table 1. Of the six industrial categories the Drexel data shows that petroleum and coal products represent the most significant single category, with 59 percent of total industrial emissions. For this reason, this abbreviated discussion (and the more detailed analysis from which it is drawn) focuses on the technology for regulating petroleum refinery emissions.

Petroleum operations within the Penjerdel Region encompass a wide range of refining processes. These processes normally consist of molecular rearrangement of crude oil by high temperatures and pressures to produce gasoline, diesel and industrial fuel oil, domestic fuel oils, lubricating oils, greases, kerosene, coke, and solvents. Processes performing the various chemical changes include distillation, cracking, polymerization, alkylation, isomerization, reforming, hydrogenation and dehydrogenation. Major pollutants produced by these refinery processes include sulfur oxides, nitrogen oxides, hydrocarbons, carbon monoxide, and odors. Less significant contaminants include particulates, aldehydes, ammonia and organic acids.

Table 1

Air Pollution Characteristics of Six Standard Manufacturing Industries Accounting for 80% of 1965 Penjerdel Emissions

Industrial Category	Process Activity	Associated Air Pollution Problems
Food and kindred products	Animal slaughtering; curing and smoking of meats; processing of dairy goods, fruits and vegetables, beverages; milling of grain and feed; animal rendering and manufacturing of fats, oils, grease, etc.	Primarily odors especially from rendering of animal matter and from decomposition of foodstuffs resulting from unsanitary conditions. Odors from handling of by-products and coffee roastings. Dust from feed and grain mills.
Paper and allied products	Manufacturing of paper and its products from wood, cellulose and rags which involves cutting, crushing, mixing, cooking and milling.	Dust and aerosol mist problems. Chief problem concerned with combustion emissions from heat and power generation for processing equipment.

Table 1 (cont'd)

Industrial Category	Process Activity	Associated Air Pollution Problems
Chemicals and allied products	Manufacturing of wide variety of products including, but not limited to: petro-chemicals; industrial chemicals including sulfuric acid, soda ash, caustic soda, chlorine and ammonia; pharmaceuticals; pesticides; plastics; cosmetics; soap; synthetic fibers; (i.e., rayon, nylon, pigments, etc.); and nuclear fission products.	Very broad range of emissions including chemicals used in the process and end products.
Petroleum and coal products	Refining and marketing of petroleum products, i.e., gasoline, kerosene, fuel oils, lubricating oils, and solvents. Coal coking, asphalt paving and building block manufacturing.	Chiefly hydrocarbons, sulfur oxides, carbon monoxide, oxides of nitrogen, aldehydes, odors, dusts and aerosols. Most emissions from catalytic cracking units, treating units, flares, storage tanks, process heaters, and batch operations for asphalt.
Stone, clay and glass products	Manufacture of glass, cement, concrete and gypsum products; cutstone materials; abrasive and asbestos products; roofing materials and bricks. Involves crushing, mixing, grinding, batching, drying and baking in kilns.	Major emissions related to dusts from mechanical operations, smoke, fumes and odors from melting and baking processes.
Primary metals ferrous and non-ferrous	Primary smelting: smelting of ore to obtain metallic elements steel mills: manufacturing of various alloys of steel Foundries: cast metal products in molds	Metalic oxide fumes, carbon monoxide, smoke, dusts and flyash from melting procedures.
	Secondary Smelting: separation of ingots of each element from scrap.	Depending on metal smelted: sulfur dioxide, lead and arsenical copper.

Source: Air Pollution Control Field Operations Manual, A Guide for Inspection and Enforcement, compiled and edited by Melvin I. Weisburd. Public Health Service Publication #937, 1962.

Control of refinery emissions is achieved through three general methods: (1) process changes including improved methods of shutdowns and start-ups and new cracking methods, such as use of hydrogen treatment instead of chemical treatment for crude petroleum; (2) control equipment, consisting of floating roof tanks, high efficiency dust collectors, waste heat boilers for catalyst regenerators, smokeless flares, vapor recovery systems and sulfur recovery systems, all of which decrease the volume of total emissions ejected into the atmosphere; (3) improved maintenance and surveillance of equipment as a preventive method.

Because of the large quantity and variety of refinery emissions, the most important considerations relate to capacity, type of process, composition of raw materials to be processed and status of control measures for individual plants. Technological progress continues to be slow and difficult, in part because specific controls and variation in controls are required for individual refineries.

4. Electrical Power Generation; Commercial, Institutional, and Governmental (CIG) Fuel Burning; Domestic Combustion

Technology for control of these three industrial categories can be approached in terms of both the fuels employed in the combustion process and the pollutants resulting. The primary fuels burned in stationary heating generating sources including major steam generating power plants and domestic furnaces and boilers, are coal, oil and gas. Of the three, combustion of the fossil fuels coal and oil is responsible for a significant proportion of our national air pollution emissions. Sulfur oxides, oxides of nitrogen and particulate matter are major pollutants formed as a result of the combustion process. Incomplete burning also creates carbon monoxide and hydrocarbons, which are relatively easily controlled. Sulfur and nitrogen oxides and particulates are perhaps the most significant urban air contaminants.

In terms of the three identified categories discussed in this section, requirements for control for the CIG and domestic fuel burning sources are known, but difficult to realize. Substitution of low sulfur for high sulfur content fuels and more efficient burning operations, and particulate collectors are the primary remedies. Technological emphasis is needed on the development and use of control equipment devices for the large capacity steam generating boilers used in electrical power plants. These electrical power plants constitute the primary source of sulfur oxides (48% of all emissions) in the Penjerdel Region.

Control technology for sulfur oxides continues to be the major problem. Present methods for reduction of these oxides include use of low sulfur fuels, stack gas cleaning, desulfurization of fuel, and use of higher stacks to disperse contaminants. Stack gas cleaning is one technique which requires a large initial investment and high maintenance costs. As with the major approaches to controlling sulfur oxides when oil is used as a fuel (scrubbers, fabric filters, electrostatic precipitators), there is the difficult step of changing sulfur dioxide into a collectable form. All techniques thus far designed to eliminate sulfur oxides have been very expensive. Present hopes for substantial reduction of this contaminant lies predominantly with burning of low sulfur fuels.

Oxides of nitrogen emitted as a result of high temperature combustion have been reduced partially through redesign of the firebox and through catalytic measures to reduce flame temperature while maintaining boiler efficiency. Particulates have been adequately collected and substantial reductions made through devices which are 99% efficient for particles of less than one micron in diameter.

5. Refuse Incineration

Incineration is responsible for roughly seven percent of the atmospheric pollution in the Penjerdel Region. Reduction of atmospheric emissions from incinerators is best accomplished by controlling combustion practices. Factors influencing efficient operation include chamber temperature, rate of burning, proportion of combustion air, and uniformity in charging the incinerator. Design criteria are also a determining factor in the control of emissions. For example, the use of multiple chamber incinerators permits combustion gases enough mixing time to completely burn combustible organic and inorganic matter and provides ample space for any particulates to impinge on chamber walls and settle out.

The primary odor control method used is afterburners attached to the discharge side of the unit to facilitate the complete burning of odor causing organics and smoke. However particulate emissions remain virtually uncontrolled in this type of process. Switching to multiple chamber designs with afterburners produces a significant decrease in these emissions. Many municipally operated and special process incinerators for industrial wastes require more efforts at controlling the increased amounts of particulates discharged. Odors from industrial and commercial incinerators emanating from specific by-products and wastes also require greater technological innovation than is provided by an afterburner at the stack.

The key to refuse incineration control is the application of afterburners to eliminate smoke and odors formed by the burning of organic type wastes. Adequate control for particulates must be handled in the basic design, redesign and construction of incinerators and through the use of various types of flyash and dust collectors.

Summary

This section has summarized study materials touching on control methods and devices for six major pollutant categories. For the most part, adequate control requirements have not yet been achieved. Source control requirements include substantial investment in installing, operating and maintaining control devices, and improved methods for the reduction of sulfur oxides and oxides of nitrogen from combustion sources. A very limited number of political jurisdictions have enacted control legislation to provide the incentive to basic technological overhauls required to eliminate certain pollutants. Los Angeles County, the States of California and New Jersey, and the City of New York are examples of jurisdictions which have provided incentives. Significant emission reductions, nationally and in this region, can only occur when we speed the application of improved source control technology and acted on what we presently know concerning the impact on air pollution of the use of certain fuels and fuel burning practices.

C. Ambient Air Quality Standards - Review, Appraisal and General Conclusions

1. Definition of Ambient Air Standards and Criteria

An ambient air quality standard sets a quantative limit on the amount or concentration of a pollutant to be tolerated in the free atmosphere, normally as measured at a representative point near ground level. Such standards describe the pollutant to be controlled and, in numerical form, the degree of air purity required for the protection against negative health effects and plant and property damage. Atmospheric concentrations of the identified pollutant above the level stated in the standard are either prohibited altogether, or allowed to exist for a limited period of time.

As employed in the United States, ambient air quality standards generally have three features in common: (a) an allowable concentration expressed in parts per million (ppm) for gases, and in micrograms per cubic meter for solids; (b) an "averaging time," which is a stated time period over which the concentrations are measured, computed and recorded; and (c) the frequency, or percent of time of occurrence during which the stated concentration may or may not be exceeded. For example, a sulfur dioxide standard might state that a concentration of 0.10 ppm, averaged over a 24 hour period must not be exceeded during more than one percent of the days in any three-month period. Jurisdictions within the United States and some foreign countries which have adopted air quality standards have utilized these features in several combinations to produce multiple standards. Different concentration limitations in ppm may appear in regulations for a variety of averaging times such as 30 days, 1 day, 8 hours, and one hour.

Ambient air criteria are not the same as standards. The basic distinction is that criteria are an expression of the relationship between air pollution and its possible harmful effects on man, animals, vegetation, and property. Criteria indicate the nature and the extent of harmful effects associated with the occurrence of specific levels of air pollutants over various time periods and thus serve as guides for the development and promulgation of ambient air quality standards. In many jurisdictions, however, this distinction is not observed. Concentrations that are set as maximum limits or averages are often called air quality standards. The literature of the air pollution field, similarly, has frequently used interchangeably the terms "standards", criteria, guides, objectives and regulations.

2. Review of Existing Air Quality Standards

Ambient air quality standards have existed in the United States since 1959 when California adopted the first set of standards. Since that time various state and metropolitan areas have either promulgated or proposed such standards.

Two national government agencies, the Atomic Energy Commission and the Public Health Service, nine states and seven metropolitan jurisdictions, a total of eighteen governmental agencies, had existing or proposed ambient standards in mid-1968. A total of eight foreign countries have also promulgated such standards. Thus, a total of twenty-six political jurisdictions in the United States and abroad have developed ambient standards for a wide variety of air pollutants. Standards reported by these jurisdictions were examined as part of this study.

Pollutants for which air quality standards are proposed or exist may be classified into three general categories: (1) non-specific solids including suspended and settleable particulates: (2) specific solids such as beryllium, lead, and sulfates; (3) gases and vapors, for example, sulfur dioxide, carbon monoxide, nitrogen dioxide, and odors.

Of those different pollutants for which standards were available, the most frequently regulated is sulfur dioxide. Twenty-one jurisdictions reviewed have such a standard. New York State and St. Louis Metropolitan Area have the greatest number of standards for separate pollutants of any American jurisdiction with ten. Of foreign jurisdictions, the U.S.S.R. has the broadest coverage with twenty-six standards for gases alone.

Ambient standards have been formulated and applied in quite different ways. For example, some jurisdictions state that concentrations cannot exceed allowable limits within certain land use areas. Alert systems of several air pollution control programs use standards as an implicit warning to the control agency that if definite precautionary enforcement tactics are not taken to control the build-up of pollutants, they can expect excess deaths, physiological discomforts to citizens, costly damage to vegetation and reduced visibility. However applied, the common, difficult problem with ambient standards is that there are no enforcement measures, which can be taken to maintain the standard short of eliminating or preventing all contaminants from entering the atmosphere.

3. Evaluation of Existing Air Quality Standards

Four general guides were used in appraising air quality standards from the various jurisdictions. These guides are comprehensiveness, consistency, adequacy, and stringency. Comprehensiveness of the standard relates to whether the standard is completely and adequately stated. The various factors, including concentration value(s), allowable frequency of occurrence, measurement time, and a method of determining whether the standard has been exceeded (such as safety factors or variable meteorological considerations), should be described. Adequacy of the standard relates to existing knowledge concerning air quality, susceptibility to translation into specific emission regulations, and potential for enforcement actions under the standard. Consistency relates to comparisons with standards of other jurisdictions with similar land uses, industrial development, and population distributions; both methods of measurement and the units in which values are expressed may be compared. Stringency, the final criteria, was evaluated by means of a special statistical analysis developed for this study. A procedure was developed for appraisal of major gaseous pollutant standards by which they were converted to equivalent values and ranked comparatively, based on the pollutant concentration they permit.

Standards for three basic categories of pollutants - (1) non-specific solids, (2) specific solids, and (3) gases, vapors, and odors - were evaluated using these criteria. The following material represents a brief summary of the detail developed during the course of analysis.

a. Non-Specific Solids

Non-specific solids include settleable particulates, suspended particulates, and soiling index. Next to sulfur dioxide, standards for settleable and suspended particulates represent the largest group. In many jurisdictions where atmospheric limits have not been established for most other pollutants, settleable and suspended particulates will be monitored and limits stated. Although soiling index is not in itself an air pollutant, it refers to the measurement of fine suspended matter in the atmosphere.

Ambient air standards for the non-specific particulates are generally based on aesthetic effects. Most of the jurisdictions studied have settleable and suspended particulate standards, but there was no significant pattern by which jurisdictions adopted these standards. For example, soiling index standards were not necessarily used by all jurisdictions having total suspended particulate limitations. Nor did all jurisdictions with a standard for suspended particulates have standards for settleable particulates.

In general, standards for non-specific solids are compehensive in that they employ areal coverage, multiple values for allowable frequencies, and sampling times. The usual basis for these standards, particularly for settleable particulates, has been subjective responses as to what is considered clean or dirty - measured in micrograms per cubic meter. The design of these standards has been accomplished usually by determining the existing level of air quality in the community and adopting a standard which to some extent is designed to reduce existing effects.

Evaluating the consistency of standards for non-specific solids proved difficult due to the variables of averaging time, maximum values over different allowed frequencies, and dfferences between definitions of land use area of particular jurisdictions. Units of measurement and the sampling methods used are generally consistent among jurisdictions for settleable and suspended particulates. Consistency within the range of values, however, was quite limited owing to the variable qualifying conditions of the standard. This was particularly true of the soiling index standards where no valid range could be given and only two jurisdictions had the same standards. Measurement times for soiling index were not listed with the standard, further complicating the process of comparability.

In terms of adequacy, ambient standards for non-specific solids are not the strong enforcement tool which a reading of their language might suggest. As with other categories of pollutants, these ambient standards have not been established by determining values which, if exceeded, will result in specific damage. Such a determination is a function of exposure or duration, including such factors as weather patterns, topography, season, and characteristics of emissions and their effects. Standards, however, have frequently been promulgated without information on these factors.

As a general rule applicable to all ambient air quality standards, existing standards are designed to protect health and property only from peak concentrations over short time periods. Enforcement of air quality standards usually is accomplished (1) by setting emission regulations for sources of emissions, and (2) by curtailing emissions when emergency conditions from atmospheric stagnation occur. But efforts to use ambient standards as a compliance measure for a single point source involve the difficult problem of demonstrating a clear relationship between what comes from a stack and the concentration measured at ground level. Acceptable enforcement procedures involve efforts to use diffusion characteristics downwind from a source of pollution, and determination of what emissions emanate from the source itself.

In terms of stringency of standards for non-specific solids, those jurisdictions which have a certain value that cannot be exceeded at any place or at any time within a definite land use pattern are more stringent than those which allow the standard to be exceeded under certain conditions. Stringency has been characterized primarily by the language of the standard. Few instances occurred where all qualifying conditions, such as averaging time and frequency, were the same and only values needed to be compared. Nonetheless, the standards examined reflect a wide range in stringency. For settleable particulates, Wyoming's standard of 10 tons per square mile per month in residential areas and 20 tons in industrial areas is among the most stringent. Values in other jurisdictions are sometimes more than twice the Wyoming standard. For suspended particulates, the standard set by the State of Delaware at 500 micrograms per cubic meter is among the most stringent. Other values examined range much higher. It was not possible to compare standards for soiling index.

b. Specific solids

Particulates classified as Specific solids include both metals and non-metals. Most of the standards in this group existing in the United States relate to two metals, beryllium and lead, and sulfur based compounds among the non-metals. Only one Federal agency, five states (including New York and Pennsylvania) and one metropolitan interstate area currently have standards for metals.

Sulfur based compound standards consist of three major types, (1) sulfate salts, (2) sulfuric acid mist (both sampled by high volume filtration) and (3) sulfation, a general index of sulfur compounds. Emphasis on the measurement of these sulfur compounds has been intensive because of adverse effects associated with the aerosol type mists formed in the atmosphere by combinations of these compounds and particulates. Investigators have described the association of the various air pollution episodes, such as Donora, Pennsylvania (1948), New York City (1961 and 1964), and London (1952 and 1956) with high concentrations of these sulfur compounds and sulfur dioxide gas.

Concerning the metals, there has been considerable controversy concerning the validity of the data regarding predictive health effects from exposure to lead. The health effects portion of this study associated lead with certain diseases. But to date the only standards for lead have been threshhold limit values for industrial workroom areas. Beryllium standards have been proposed in some jurisdictions which have industries using this metal in their process. Known to be highly toxic to humans, beryllium standards have been placed at very low values. Pollutant levels for these two metals are measured in the same manner that suspended particulates are sampled. In general, standards for specific substances have much in common with the suspended particulate standards previously discussed.

In terms of comprehensiveness, the most complete standards for specific solids are for the non-metal sulfurous compounds. Levels established for sulfates, sulfuric acid, and sulfation are all expressions indicative of pollution from particulate sulfur compounds. The major feature of most of the sulfur standards is that they apply to the entire geographical area of a political jurisdiction, independent of land use. Yet few jurisdictions have such standards. For instance, only one jurisdiction has a standard for sulfation, which is a general measure of the relative amount of pollution from sulfur compounds, both gaseous and particulate. The most comprehensive standards for specific solids appear to be those developed in a study of the St. Louis metropolitan area.

In terms of adequacy, as previously indicated, ambient standards for specific solids have no effect from a preventive standpoint. Whether or not a maximum value is or is not exceeded can only be determined after the fact and the source of the excess is difficult to determine. For specific pollutants, the standards for fluorides and lime dust also appear adequate with relation to jurisdictions affected. Valid standards for such specific solids as vanadium and iron oxides must be developed for use by jurisdictions containing sources of these pollutants.

In terms of consistency, there are examples of identical standards such as New York State and the U.S.S.R. for sulfuric acid mist, and New York State and Montana for beryllium. But again comparisons in values for respective pollutants are difficult because of differences in the expression of the standard. Further, the limited number of U.S. and foreign jurisdictions having air quality standards for specific solids makes comparisons less significant.

With relation to stringency, the most restrictive of the standards are those in the sulfuric acid mist group, with both New York State and metropolitan St. Louis having similar strict standards, though differing slightly in averaging times and concentration values. The Atomic Energy Commission employs a restrictive standard for beryllium, based on a single measurement.

In summary, only a negligible number of specific solids standards are in existence. The lack of standards for other specific solids may be a result primarily of ignorance as to the presence and effect of these solids. With more sophisticated, complete, and very specialized monitoring equipment being employed in the future, it will be possible to identify the presence of other solid pollutants in the atmosphere. Through more extensive health research, the effects of these pollutants may be determined. Research on beryllium demonstrated the toxic effect on human beings. The combination of monitoring operations and health effects study should produce a number of stringent standards for a variety of specific solid contaminants. Rational development of public policy requires such information for all categories of pollutants.

c. Gases, Vapors and Odors

This is perhaps the most significant category of pollutants for which standards are required. The largest number of ambient air standards and regulations has been established for gaseous pollutants. Specifically, sulfur dioxide, carbon monoxide, oxidant, and hydrogen sulfide are pollutants for each of which standards have been enacted in a fair number of American or foreign jurisdictions. Oxides of nitrogen and nitrogen dioxide are prominently known pollutants. However, standards for these two gases were available for only three American political jurisdictions and two foreign countries. Each of the other gaseous pollutants, namely, fluorides, ethylene, carbon disulfide, ozone, hydrogen chloride, chlorine and nitric acid, are regulated by a very small number of political jurisdictions throughout the world.

There is great diversity in existing ambient air quality standards for gaseous pollutants. Differences in air quality standards occur in the concentrations of pollutants permitted, the frequency with which these concentrations are permitted to occur, and averaging time. Differences in air quality standards result in part from varying estimates of the effects of various gaseous pollutants regulated, the land use pattern of jurisdictions doing the regulation, and the estimated diffusion impact of meteorology on pollutant accumulations within the area regulated.

In terms of comprehensiveness, there are twenty-one American and foreign political jurisdictions with one or more standards for sulfur dioxide. Many of these jurisdictions set different pollutant concentration levels for different averaging times such as twenty-four hours, eight hours, and one hour. Several jurisdictions use an annual average: Pennsylvania uses a 30 day average. Sampling and monitoring techniques are capable of measuring concentrations and computing averages for these various time intervals. Some monitoring instruments can compute data for time periods as low as five minutes. The United States Public Health Service and Metropolitan St. Louis have sulfur dioxide standards expressed as five minute averages. Another type of standard is employed by the San Francisco Bay Area Air Pollution Control District and the nation of West Germany, which have sulfur dioxide standards with parameters expressed as exposure values rather than averaging times. San Francisco uses four formulas based on cumulative exposure for values over various periods including total monthly exposure. Within the United States, the State of California has a very complete set of ambient air quality standards, covering seven gaseous pollutants.

In terms of adequacy, ambient standards in existence for gaseous pollutants reflect only the most severe effects from high doses over short periods of time. Present standards provide no protection against the long-term cumulative impact of low-level concentrations. The health impact analysis undertaken as a part of this study indicates the potential threat represented by such exposure. Moreover standards are always related to a single pollutant (such as sulfur dioxide); standards that take cognizance of the possible combined effects of pollutants on the human body do not yet exist. The general paucity and slow development of air quality standards nationwide is alarming. Since the states are now required to enact such standards following Federal designation of air quality regions, there is some cause for optimism that standards research will be stimulated. The criteria and data to be used in establishing air quality standards is a major concern. States should not engage in the practice of using standards previously adopted by other agencies without research and evaluation.

As to consistency, in general all standards for gaseous and vaporous pollutants are expressed in parts per million (ppm). Consistency stops with this level of agreement. Averaging times vary widely. Concentration levels permitted also vary widely for the same pollutant. These variations were reflected in each of the twenty-one jurisdictions which had standards for sulfur dioxide. The majority of jurisdictions express their values as concentrations over averaging times stated either as maximum values not to be exceeded, or as values not permitted to occur more than a defined percentage of time. For example, the State of Colorado forbids concentrations of 0.10 ppm to be exceeded 1 percent of the time during any three month period anywhere in the state; the State of Pennsylvania for all land uses set 0.50 ppm as a maximum one hour average not to be exceeded, 0.25 ppm as a maximum 24 hour average not to be exceeded, and 0.05 as a maximum 30 day average; the State of Delaware for industrial land uses has a 0.06 ppm limit as a 24 hour geometric mean on an annual basis.

A source of inconsistency among standards for gaseous pollutants is the imprecision and lack of clarity in language. For example, is the clause "not to be exceeded 1 percent of the time during any 3 month period" the same as "not to be exceeded 1 percent of the days in any 3 month period?" As another example, is the standard 0.5 ppm sulfur dioxide expressed as a maximum one hour average in one jurisdiction the same value as 0.5 ppm as a maximum 5 minute average not to be exceeded more than once in eight hours, used by another agency? There are more divergent standards for sulfur dioxide than for any other pollutant. Carbon monoxide standards, while not as numerous as those of sulfur dioxide, also have widely scattered values.

The comparative stringency of standards for sulfur dioxide, carbon monoxide, oxides of nitrogen, nitrogen dioxide, and total oxidants was evaluated by means of special statistical techniques developed for this study. Using this statistical procedure, tables of standards converted to equivalent values for seventeen American and four foreign jurisdictions were prepared, comparing states such as California, Colorado, Delaware, Montana, New York, and Pennsylvania, counties and metropolitan areas such as Los Angeles, and foreign countries and regions, such as Czechoslovakia, the U.S.S.R., and Manitoba, Canada.

The basic conclusion resulting from an examination of these specially prepared tables was that the degree of stringency among the various standards representing different jurisdictions or different standards within the same jurisdiction varied tremendously. For example, the values in sulfur dioxide standards, after statistical conversion to a common base, vary from 0.0116 ppm in the USSR to 0.7659 ppm permitted under certain conditions in California. The USSR value is more than 65 times as stringent as the California value. These are the extreme values of the range. Nonetheless, there is also a wide gap in sulfur dioxide standards among United States jurisdictions. The sulfur dioxide standard for rural areas of the Southwest Ohio - Northwest Kentucky (SWONK) study is equivalent to 0.0153 ppm, or 50 times as stringent as the California standard.

Carbon monoxide standards converted to a common base by the same statistical procedure range from 0.2824 ppm in Czechoslovakia to 48.018 ppm in Los Angeles County. In this case the Czechoslovakia standard is about 170 times as stringent as the Los Angeles standard. A Montana standard for carbon monoxide is about 25 times as stringent as Los Angeles.

Only a few jurisdictions have ambient air standards for oxides of nitrogen and nitrogen dioxide, and the variation in stringency is smaller. The most stringent standard is approximately three times the value of the standard in the least stringent jurisdiction. A similar comparison was made among 17 ambient standards for total oxidants. In this case, a Montana standard was found to be three times as stringent as a standard used by the Southwest Ohio-Northwest Kentucky (SWONK) study.

This analysis was performed not to evaluate any particular standard or set of standards, but rather to gauge the degree of agreement on the desirable quality of the ambient atmosphere. The obvious lack of consistency and uniformity suggests that many standards are perhaps designed to reflect what the quality of the air is at present, rather than what it ought to be.

d. Summary and Conclusions

On the basis of this analysis and review of American and foreign ambient air quality standards for gases and solids, the following general conclusions can be summarized.

(1) The term "ambient air quality standard" should be precisely defined and not used interchangeably with such terms as criteria, goals, guides, or objectives. The notion of an air quality standard should be limited to a specific quantitative limit on the amount of a pollutant to be permitted in the ambient atmosphere established by a governmental jurisdiction to provide a rational basis for the establishment of emission regulations.

(2) Ambient air quality standards are generally presented in terms of values or concentrations that may be exceeded only over a defined frequency, and for a specific amount of time (averaging time). While this concept has resulted in adoption of some useful standards designed to protect man, animals, vegetation and property from the acute and toxic effects of pollutants, many standards presently enacted are extremely complex, confusing, and virtually unenforceable.

(3) Air quality standards should be developed and promulgated for more solid pollutants including trace metals. Improvements in monitoring technology should help document the necessity for additional standards and suggest parameters and goals for regulation. Foreign countries have enacted more stringent standards for specific compounds and elements than many U. S. standards.

(4) Establishment of air quality standards should be followed by a precise statement deccribing the methods of measurement to be used and the conditions under which sampling is to be performed to determine if the standards have been exceeded. These matters may be appropriately treated in a technical appendix to the standards.

(5) In conjunction with the health effects portion of this study, perhaps the most significant single conclusion of this report is the following: air quality standards should be developed and stated not solely in terms of acute effects of a single pollutant, but also to reflect the cumulative impact of a combination of pollutants. It seems inevitable that an approach to standards which gives greater consideration to the long-term effects of exposure to small quantities of pollutants will produce far more stringent regulations.

(6) In analyzing existing standards, one generally finds identical or reasonably similar concentration values, but different averaging times. Achieving greater uniformity in air quality standards will require agreement on the specific criteria for which the standards are adopted. In this connection, the health of members of society afflicted with respiratory ailments would be a more appropriate criteria than the health of a "normal" individual.

(7) The practice of adopting regulations and standards of some other political jurisdiction or professional organization should be rejected unless it is accompanied by careful research explorations.

(8) More effort will be required toward development of standards for odors. Including odors as a part of general nuisance regulations makes their elimination legally difficult.

(9) Differences between standards are frequently a result of performance standards attached to the standard. Conditions under which a given level of a pollutant is considered to be hazardous may be stated in terms of distance from property lines, meteorological conditions, land use and zoning patterns, and alert systems. While complete uniformity of standards is not appropriate, some performance standards - particularly set-back from the property lines of pollutant source - have no place in a technologically sophisticated system of environmental standards.

(10) A statistical comparison made of the stringency of air quality standards for gaseous substances, shows a tremendous variation in the actual concentration levels used as standards. The implication is that too many standards reflect the present quality of the atmosphere rather than what it ought to be.

(11) Enforcement of air quality standards is normally possible only after the standard has been exceeded for a certain period of time. But using air quality standards as the means for limiting emissions from a particular source is a difficult if not impossible task. Only rarely have ground level measurements been used in conjunction with diffusion formulas to determine concentrations emanating from an emission source or group of sources. Thus, the main effect of an air quality standard is simply to provide a basis for the continuous measurement and appraisal of a community's air quality. Therefore, once air quality standards have been established, emission regulations consistent with these standards must be established if substantial improvements in existing air quality are to be effected.

(12) Under the Air Quality Act of 1967, the Federal government has given the states responsibility for development of ambient and air emission standards, with Federal review for air quality control regions designated by the Public Health Service. As has been indicated previously, air quality standards should be based on criteria which express the best scientific knowledge on the relationship of concentrations of pollutants to adverse effects on man, animals, vegetation materials, visibility, and human welfare. Clearly, scientific data on health effects available to each state should be used in establishing standards for air quality regions within the state. But adoption of air quality standards must be made on the basis of the best available data and must not be made to await final proof of cause and effect between various pollutant sources and various levels of disease.

D. Emission Regulations and Standards - Review Appraisal, and General Conclusions

1. Background and Review of Emission Standards.

Emission standards are best defined as limits placed upon the amount of pollutants discharged from any source. As indicated previously, they are performance standards designed to achieve a desired level of air quality. Regulations for emissions are usually expressed in combinations of four terms: volume, weight, power, and time relationships. Specific examples include: parts per million (volume), milligrams per cubic meter (weight), pounds per BTU input (power), and pounds per hour (time). A fifth type is based on visible characteristics of plumes and and is measured by a Ringlemann chart, which has been explained.

Perhaps the oldest known emission regulations in the United States are smoke emission ordinances enforced through zoning and building codes. In the Penjerdel Region, a number of local jurisdictions have visible smoke emission regulations, using the Ringlemann Smoke Chart. The Ringlemann capacity index is a widely accepted procedure for determining violations from stationary fuel combustion sources.

Another common emission standard is the American Society of Mechanical Engineers (ASME standard for particulates, set at 0.85 pounds per 1000 pounds of exhaust gas. Recommended in 1949, this standard is still incorporated in the air pollution code of the City of Philadelphia. Since 1949, a new ASME standard has been designed, based on such operational features of equipment as process weight and rated capacity. Emission standards concerned with other specific pollutants are slowly emerging. As a general rule, however, emission standards most frequently used in the United States are either visible smoke regulations or particulate regulations following the ASME code.

Following the format used in the analysis of ambient air quality standards, four general categories of emissions standards - (1) non-specific solids, (2) specific solids, (3) gases, vapors, and odors, and (4) visible emissions - will be reviewed in terms of comprehensiveness, consistency, adequacy, and stringency. Non-specific solids include dust, fumes, soot, smoke, flyash, all of which are included in the term particulates; specific solids examined include beryllium, barium, chromium, sulfuric acid, and fluorides, which are regulated by some foreign countries but few American jurisdictions; gases, vapors, and odors relate to carbon monoxide, oxides of nitrogen, hydrocarbons, sulfur dioxide (the most frequently regulated gaseous pollutant) and all substances capable of producing an odor considered to be a health nuisance.

Unlike ambient air quality standards, emission regulations are linked to specific sources of contamination. Frequently, these emission limits are set as performance requirements that must be maintained as a function of the specific source, activity or process in question. For example, in motor vehicles a limit is set on amount of hydrocarbons discharged from the crankcase, carburetor and exhaust. Other emission regulations limit dust and particulates from such specific sources as Bessemer converters, sintering plants, and basic oxygen furnaces used in steel manufacturing and fabrication.

Emission regulations are the basic enforcement tool of an air pollution control agency. When developed in conjunction with ambient air quality standards and criteria and strictly enforced, they serve to maintain a given quality of air. Many jurisdictions, however, have only smoke and general particulate emission regulations, and most of these are antiquated and not fully enforced. As performance standards, emission regulations should be quantitatively related to ambient air quality standards. The air resource management concept emphasizes this approach by first establishing air quality standards as a basis for emissions limits required to achieve the desired air quality.

2. Evaluation of Existing Emission Regulations

Emission regulations are more specific than ambient standards since they contain precise information regarding the conditions of effluent discharge. Many regulations are related to a specific source or process, while some apply to all sources in general. Emission regulations may include such factors as rated capacity of equipment, stack height, particle size, and process weight as determinants of allowable limits.

a. Non-specific solids

Turning first to emission regulations for non-specific solids, it is apparent that numerous jurisdictions have regulations for particulates and dusts, the most common of which is the ASME standard regulating fuel burning. Some jurisdictions have particulate emission limitations applicable to all source categories. Other emission regulations relate only to processes of incineration, transportation, fuel combustion, or a combination of these. The most comprehensive emission standards are those based on ambient air quality standards.

Because many jurisdictions use the ASME value, emission regulations for non-specific solids tend to be extremely consistent in terms of the stated limits. Moreover the units of measurement for nearly all non-specific solid emission regulations are convertible or interchangeable; the units are a weight per unit volume expression which is a measure of density of a weight-rate relationship. Thus there is a high consistency of generic relationships such as weight per unit volume among this set of emission standards. However there are some inconsistencies and deviations. For instance, while the vast majority of jurisdictions measure contaminants in terms of effluent discharge, the Commonwealth of Pennsylvania and a few other jurisdictions have emission regulations based on ground level concentration limits as measured outside the property line of the emission source.

On the issue of adequacy and enforcement of emission standards for non-specific solids, many jurisdictions simply do not possess either the instrumentation or trained staff to implement emission regulations. The primary and most easily used enforcement tool is observation and evaluation of smoke plumes, and that procedure requires trained personnel. Some regulatory agencies have adopted emission standards incorporating other factors including stack height, plume rise and dispersion, process weight, heat input, meteorological conditions, and property boundary. The use of some factors, such as process weight and heat input, produce a more precise standard than a general emission rate for all sources, but others such as measurement of property line-ground level concentrations at property lines produce inconsistency and are inappropriate. With the increase in urban sources and improved quality of control apparatus and source sampling, new and more restrictive regulations for non-specific solids should be adopted.

In connection with the degree of stringency, it is extremely difficult to evaluate the real restrictiveness of regulations when variable operating conditions are attached to the standard. However some comparisons of emission regulations for non-specific solids were made by translating the standards into approximate equivalent values expressed in milligrams per cubic meter. The range of values examined indicated substantial differences in stringency reflecting different values in regulations. This may reflect the fact that emission regulations may be geared to achieve different goals including the best control technically feasible, minimum limits based on the number and type of sources, and source reduction requirements necessary to meet specific air quality standards. Greater stringency will result when emission regulations are based more on the second and third considerations, in line with the air resource management concept.

b. Specific solids

Emissions of specific solids are comprised primarily of metallic elements. There is a paucity of standards for such emissions. The states of New York and New Jersey are the only American jurisdictions with specific solid regulations. The American regulations relate primarily to manufacturing sources. Emission regulations for specific solids have many common elements with the non-specific solids. Again, incorporation of stack height, boundary line specifications, process weight and other factors are sometimes related to the standard. The regulations in both U.S. jurisdictions have notable features. New Jersey uses effect factors which are multiplied by a basic emission limit to obtain the amount specified as the allowable emission for a certain contaminant. New York's regulations are classified into three categories based on the possible effect of the pollutant in question on man, animals, and vegetation-property. Yet the allowable emission rates are flexible, depending on the potential emission rate and the efficiency of existing control equipment.

In terms of comprehensiveness of coverage in the two states which have regulations pertaining to specific solids, New Jersey regulates seventeen metals and four non-metals, New York three metals, and two non-metals, beryllium and lead being among the most important. Evaluating consistency and stringency is difficult because of the use of effect factors, and control system efficiencies are used. New Jersey and New York regulations are expressed in pounds of emissions per hour. On the issue of adequacy, enforcement under the New York regulations is not undertaken; the regulations serve as guides. New Jersey regulations both require the firm to furnish information and make possible control agency emission sampling. Both enforcement options must be available for effective enforcement.

c. Gases, vapors and odors

Gases, vapors, and odors are the major contaminants presently of concern to officials and agencies in the air pollution field. Yet the number of jurisdictions having regulations for specific gases and vapors are few - far less than those regulating non-specific particulates or visible emissions. Sulfur compounds, carbon monoxide, hydrocarbons, and oxides of nitrogen are the most frequently regulated; other gaseous pollutants for which emission limits exist include organic solvents, perchloroethylene and toluene, carbonyls, hydrofluoric acid, chlorine, hydrogen chloride, nitric acid, fluorides, phosphoric and chromic acids.

Concerning comprehensiveness of the coverage of existing standards, the Federal emission regulations established for carbon monoxide and hydrocarbons from motor vehicles are examples of complete 100 percent coverage. Oxide of nitrogen emissions from vehicles, as previously noted, are presently uncontrolled. Among all jurisdictions, sulfur dioxide was the most frequently regulated emission, with most jurisdictions regulating only a few additional gases and vapors.

Emission regulations for sulfur compounds include a wide range of related substances, including sulfur trioxide, sulfuric acid, and hydrogen sulfide in addition to sulfur dioxide standards. Again, the expression of allowable emissions in regulations are varied, often including factors of stack height, property line boundaries, process weight, heat input, and variations in control equipment efficiency. Many regulations and emission limits consist of one value for specific or general sources. Of sixteen jurisdictions studied, eleven had emission limits consisting of only one value. In general, the New York State, and proposed St. Louis Interstate and the New York - New Jersey Interstate regulation appear to be most comprehensive in the application of their sulfur dioxide standards to stationary sources.

With reference to consistency, the Federal standards for gases from motor vehicles are uniform in all states. Regulations of sulfur emissions from stationary sources are quite similar in that eleven of sixteen surveyed jurisdictions have the identical standard of 2000 parts per million by volume. These limits appear to be based on technological feasibility, not on scientific evidence linking an emission value to ambient standards and criteria. Few if any emission limits have been designed to meet ambient standards, and are in this respect inherently inconsistent.

On adequacy for enforcement, most of the gaseous emission regulations reviewed are enforceable if the particular control agency has the staff and equipment to perform stack sampling and effluent analysis and if the source can be adequately monitored. What is most disturbing is the lack of scientific evidence supporting the specific gas emission regulations from stationary sources. Most of the work on determining limits has been done by industrial hygienists based on the the effect of gaseous substances within the industrial environment. Basically, however, their recommendations are designed to limit individual toxic substances. The concern is that combinations of pollutants may be more toxic or present difficult problems than individual ingredients. For example, sulfur dioxide is known to be harmful in high concentrations, but may produce more damage in association with suspended particulate matter. Suspended particulates are composed of many different substances which, in combination, could prove to be harmful and have cumulative toxic effects. This example makes clear the limitation in the current approach to standards which regulates single pollutants and not their combination. This point is relevant to both emission and ambient air quality standards.

The degree of stringency of gaseous emission standards cannot be determined because the regulations involve the use of factors in the regulations - such factors as process weight of raw materials, amount of heat energy, degree of control efficiency, elevations of stack heights, and the dubious use of property line distances from the source of the emission.

Turning briefly to a review of standards for odors, their regulation is usually under public nuisance ordinances. Determination of whether the odor is obnoxious is primarily a subjective matter. Thus, enforcement is difficult. Some jurisdictions do have dilution measurement techniques, associated with various land uses. For instance, in specified light industrial zones odors capable of detection beyond the industry's property line are forbidden. Subjective measures are based on a certain percentage of exposed people noticing the odor. Specific odor regulations have not as yet been incorporated into emission regulations.

Summarizing this discussion of emission regulations for gases, vapors, and odors, are the following points:

(1) The most significant gaseous and vaporous emission standards are those established for (1) sulfur dioxide emitted from stationary sources and (2) hydrocarbons and carbon monoxide discharged from motor vehicles.

(2) The most comprehensive set of standards (in terms of extent of coverage) are the vehicular emission requirements established by Federal legislation and applicable on a nationwide basis.

(3) Many jurisdictions maintain specific standards for particular industries. The greatest amount of variation is in the conditions under which the emissions are allowed. Factors such as rated capacity of equipment, heat input required, stack height, process weight and zoned areas makes the determination of consistency difficult.

(4) Enforcement is accomplished by two approaches. Measurement of effluent discharge at the source is one. Other jurisdictions determine allowable emissions by using ground-level measurement techniques outside the property line of the source. The second method uses a dispersion type formula and model to determine downwind concentrations based on a number of physical factors concerning the source.

(5) The development of emission regulations derived from ambient air quality standards is seldom accomplished. Emission regulations have been based largely on the degree of control attainable through existing technology.

d. Standards for Visible Emissions

The final category of emissions for which standards were evaluated are visible emissions. Regulations limiting the amount of smoke discharged from fuel combustion sources and open burning are the most popular and numerous of all the emission regulations. The amount of smoke permitted to escape is measured by the Ringelmann Chart, previously described.

Smoke is defined as the solids or particulates largely consisting of carbon particles that comprise the gray to black effluent from many stationary and mobile fuel burning operations. Smoke ordinances are most frequently related to fuel-fired apparatus, whether a stationary power station, a diesel locomotive, or a steamship. Incineration and open burning operations have also been included under smoke ordinances.

Smoke and visible emission regulations are most comprehensive in terms of the number of jurisdictions with such regulations. Legal acceptance of the Ringelmann chart in municipal codes across the country is the major cause. To an increasing degree, opacity rules are being adopted based on the use of the Ringelmann, giving these regulations a high degree of consistency between agencies. With reference to adequacy, these regulations are limited, but they can be enforced by trained personnel. There is also reasonable consistency of standard values with most jurisdictions allowing #1 Ringelmann readings much of the time, and #2 readings for varying lengths of time. The degree of stringency relates to these factors and the extent to which applications vary with land use and zoning.

e. Summary and Conclusions

The analysis of selected emission regulations provides a base for the following summary:

(1) Emission standards most commonly found in the United States are the visible smoke emission codes and the particulate or dust loading rule derived from the American Society of Mechanical Engineers (ASME) standard. Initially, visible emission standards were associated with the effluent discharge of smoke from stationary combustion sources. In recent years, however, visible emission regulations based on percent opacity of the plume also have been applied to other sources.

(2) In terms of enforcement, the visible emission limits using the Ringelmann Chart are the only emission regulations presently enforced on a wide scale. Though several jurisdictions have adopted particulate and dust emission standards, these are frequently unenforced because of the lack of technically proficient staff and sophisticated equipment.

(3) Emission standards for specific solids are few in number and slowly emerging. Such regulations require a knowledge of health effects as well as the industrial processes and raw materials which contribute to the total emission.

(4) Some jurisdictions have developed detailed and specific emission regulations based on performance, structural and site characteristics of the source producing the emission. Such characteristics include: property line dimensions, rated capacity of equipment, heat input requirements, stack height and process weight features of the source. Such factors have been utilized in the derivation of dispersion formulas to calculate the relative degree of ground level pollution caused by source emissions. The use of such diffusion

formulas and models to ascertain ground level values is increasing. Reliance on property line setback from emission sources for computation of ground level values is an obsolete concept and should be eliminated.

(5) The most comprehensive and uniform emission regulations existing in the country, with respect to values, are the Federal vehicular emission limits for carbon monoxide and total hydrocarbons.

(6) The basis for the limits contained in emission regulations is frequently inconsistent and uncertain. Emission regulations for certain industrial processes and equipment are set with primary reference to the specific technical reductions that can be achieved.

E. Air Monitoring Systems and Technology

1. Air Monitoring Systems: Characteristics and Objectives

The general objectives of a comprehensive air quality monitoring program are to determine (1) what hazardous substances are present in the air, (2) the effectiveness of enforcement and control measures, and (3) the categories and location of sources responsible for impaired air quality. The requirements needed to achieve these objectives of an air monitoring system include the following: (1) data measuring pollutant concentration and meteorological factors, (2) a means, using a diffusion model, of relating pollutant concentrations and meteorological and topographical data to emission sources, and (3) an alert system designed to protect health during periods of high pollutant concentrations.

Air monitoring equipment ranges in size from simple dust fall jars for particulates and lead peroxide candles for sulfur dioxide, to complex systems involving telemetering of pollutant and weather data from remote sites to a central monitoring location with continuous data charting.

a. National Air Monitoring Networks

The National Air Sampling Network (NASN) is the oldest air monitoring system in the United States. Started in 1953 and operated by the United States Public Health Service in conjunction with state and local health and air pollution control agencies, the NASN provides nation-wide basic data on the air pollution problem. Initially, operations consisted of collection and analysis of suspended particulates on a voluntary basis by local government agencies, with equipment and laboratory services provided by the Public Health Service. In 1957, NASN was greatly expanded to include trace metals, radioactive materials, organic pollutants, and precipitation.

As of 1965, there were a total of 255 local government operated sampling stations meeting Public Health Service criteria. These included 226 urban and 29 non-urban stations sampling for particulates, radioactivity, organic and inorganic substances in 1965. The NASN program initiated gaseous sampling in 1963, and as of 1965, 34 of the 255 stations were monitoring sulfur dioxide and 30 were monitoring nitrogen dioxide. Twelve sampling stations for suspended particulate and benzene soluble organics and one for sulfur dioxide and nitrogen dioxide were located within the Penjerdel Region in 1965.

b. Continuous Air Monitoring Program

A more sophisticated measurement is the solely Public Health Service operated Continuous Air Monitoring Program (CAMP), which is a system employing automatic recording devices. CAMP was initiated in Cincinnati in October, 1961. In 1962, a total of six cities - Cincinnati, Chicago, Philadelphia, New Orleans, San Francisco, and Washington, D.C., - in cooperation with local air pollution control agencies continuously monitored six gaseous pollutants. Each city has one measuring station. The number of stations still remains the same with changes in sites from St. Louis (1964) and Denver (1965) to New Orleans and San Francisco respectively. Some comparable measurements are made in other major urban areas such as Los Angeles, New York City, Detroit, and Pittsburgh.

The specific pollutant variables presently measured at CAMP stations are: suspended particulates, soiling index, sulfur dioxide, carbon monoxide, nitric oxide, nitrogen dioxide, total oxidants, and total hydrocarbons. Each of the gaseous pollutants are measured by separate instrument systems which produce electrical signals measured by a recorder. Every five minutes the signal is sent to an analog-to-digital recording instrument that automatically places the signal's impulse on a punched paper tape. The basic data represents the average pollutant level during a five minute interval as measured at one location. Some supplementary weather data is also taken at the CAMP stations.

c. State and Metropolitan Air Monitoring Networks in the Penjerdel Region

Air quality monitoring within the Commonwealth of Pennsylvania began as early as 1912, when the Mellon Institute sampled for particulates in the Pittsburgh area. Since that early date, air monitoring has been gradually expanded so that air sampling measurements now exist for ten pollutants - suspended and settleable particulates, lead, beryllium, sulfates, fluorides, sulfur dioxide, nitrogen dioxide, hydrogen sulfide, and carbon monoxide. With the adoption in Pennsylvania of ambient air quality criteria in April, 1967, the need is for an extensive sampling and analysis system to ascertain when these standards are exceeded.

Community air surveys and sampling directed at specific locations and differing from overall statewide sampling have been a part of the total monitoring program. In the period 1960-66, fifteen such community surveys covering areas with populations in excess of 1.4 million people - such as the Reading Area, Greater Johnstown, Lower Schuylkill Valley, and the Lehigh-Northhampton Valley - have been undertaken to provide some information on the quality of the atmosphere in these selected locations. More recently, a comprehensive air monitoring program plan for Pennsylvania has been developed for air quality surveillance. It involves a plan to use highly sophisticated electronic data gathering devices for area air basin pollution from multiple sources, an alert system, and special short term studies for specific pollutants. The future air monitoring program for Pennsylvania will be similar to the Public Health Service's continuous air monitoring stations. The air basin network system will be composed of semi-stationary stations equipped with eight sensing devices and capable of telemetering this information to the computer center at Harrisburg. On a regional basis, permanent continuous air monitoring stations will telemeter data to the regional office and to Harrisburg. This automatic air monitoring network is to be established under a Federal grant of close to $700,000 announced in late July, 1968.

In New Jersey, the first official statewide air sampling and monitoring program was initiated in 1956 with an experimental survey by the Department of Health conducted to design an index based on smoke emissions in the State. Late in 1961, the Research and Development Program instituted an air quality monitoring network on the basis of a soiling index study. The monitoring program consisted of 35 automatic sampling devices for soiling and smoke shade operating on a 24 hour schedule, 365 days per year. Air monitoring for sulfur dioxide, oxides of nitrogen, and total oxidants at three sites was completed in early 1961. Two mobile air sampling laboratories for enforcement and research purposes were developed in 1961.

Since 1961 New Jersey has developed a sophisticated automatic sampling and data telemetering equipment network to furnish data for an emergency early warning system and to provide information on existing air quality. The New Jersey Continuous Air Monitoring Program known as "Operation Big Sniff", is a comprehensive system. As of 1968, there were comprehensive continuous air monitoring mobile laboratories located in Newark, Hudson County Park (Bayonne) and Camden; major air monitoring stations at Camden, Hackensack, Patterson, and Perth Amboy, a central station in Trenton providing continuous recording of data from this network. By 1969, there will be 22 air monitoring stations distributed around the state. Ten major pollutants are now monitored by the laboratories including sulfur dioxide, carbon monoxide, and smoke. Another network for sampling suspended particulates is now under development. The four continuous air monitoring stations are equipped with telemetering sensors for sulfur dioxide, carbon monoxide and smoke or soiling index.

The great emphasis New Jersey places on this highly sophisticated network is partially a response to the development of an alert system as prescribed by the state's Air Pollution Emergency Control Act (1967). With this objective in sight the state's monitoring program plans to collect data for enforcement, pollutant trends, and information for developing regulations. Future expansion of the New Jersey monitoring system will involve an increase in air monitoring stations to eighteen throughout the state, the additional capacity to monitor a fourth pollutant, and integration of all data systems into a central computerized system. The fully operational system, expected to be completed late in 1968 or early 1969, will provide both a warning system and an air quality management network.

The air monitoring program for the State of Delaware is under development. Establishment, over a three year period, of an air monitoring system to measure the quality of Delaware's air - particularly in the Wilmington area - was announced in late 1966. The State of Delaware now operates two automatic continuously monitoring sulfur dioxide instruments. Future plans for air monitoring include the addition of an undetermined number of continuous air monitoring devices capable of monitoring eight pollutants including sulfur dioxide, carbon monoxide, nitric oxide, nitrogen dioxide, total oxidants, aldehydes and several others. Lack of air quality information has hampered the development of the Delaware program.

In Philadelphia, the main air monitoring facilities include the CAMP station at the Franklin Institute, which will be equipped by the City following movement of the present Federally owned equipment, a continuous air monitoring station with the Department of Health's Environmental Health Laboratory, a mobile air sampling station acquired in 1967, and a series of 12 smaller air sampling sites which monitor only particulates and soiling index. The Franklin Institute CAMP station monitors sulfur dioxide, nitrogen oxides, carbon monoxide, total hydrocarbons, and total oxidants. The mobile station includes a weather mast for determining wind velocity and direction.

With Federal financial assistance Philadelphia now plans to add four complete monitoring stations in each of the next three fiscal years. Satellite stations will also be developed, though these will not monitor all the pollutants handled by the larger stations.

In summary, monitoring programs within the Penjerdel Region are being developed with increased speed by the various national, state and local jurisdictions. The pattern of development is not integrated on a regional basis, nor are the various systems designed to be related or coordinated. Geographic coverage by monitoring stations is not complete enough to provide comprehensive data reflecting a full range of the fluctuations in air quality.

d. Instrumentation for Air Quality Monitoring - Principles of Operation and Description of Instruments

A variety of instruments and methods exist for removing air contaminants from the atmosphere for purposes of analysis either within the instrument or in an air pollution laboratory. Methods that require a laboratory use manual or semi-automatic instruments. The major pollutants measured by these devices are particulates including dustfall and suspended particulate matter. Sulfur dioxide, nitrogen dioxide, aldehydes and fluorides are gaseous contaminants which are collected and analyzed by manual methods. Other methods used to collect air pollutants, particularly gases, are entirely automatic. Automatic instruments collect, analyze, record, and are capable of telemetering their information to a central computer from remote sites. Continuous automatic recording systems consist of highly sophisticated instruments which analyze and record various pollutant concentrations over long periods of time. Such instruments are designed to determine existing pollutant concentrations, alert governmental control agencies to dangerous concentration levels, and determine meteorological conditions that effect pollutant levels and distribution.

The principal monitoring methods used by air pollution control agencies throughout the United States are summarized in the following table.

Table 2

Air Quality Monitoring Methods and Devices

1. Particulate Monitoring
    - a. Manual Methods
    - b. Automatic Methods
        - High Volume Air Sampling
        - Low Volume Air Sampling
2. Gaseous Monitoring
    - a. Manual Methods
        - Absorption
        - Adsorption
        - Grab-Sampling
        - Freeze-Out
        - Dosimetry
    - b. Automatic Methods
        - Absorptions
        - Electromagnetic
            - Spectrophotometry
                - Visible
                - Ultra Violet
                - Infrared
        - Electrochemical
            - Electroconductivity
            - Coulometry
        - Ionization
        - Chromatography

(1) Particulate Monitoring

Particulates sampled by manual methods are known as settleable particulates or dustfall. The instrumentation designed for sampling dustfall is a simple, manual collecting jar made of glass, metal or polyethylene. Sedimentation is the principle for this sampling method. The jars are exposed to the outside air for a period of approximately 30 days. Containers are widely distributed so that after laboratory analysis, the estimate of total dustfall can be used as an index of air quality.

Automatic devices for collecting and monitoring particulates are geared to those substances that are suspended in the atmosphere. Various measurement techniques exist and are specific in relation to the various purposes for which the sampling is undertaken. Thus, several techniques are available for measuring suspended particulates. The most commonly used methods are those for determining weight per unit of volume and those for measuring surface area of particles in their formation of atmospheric haze. These two techniques are used as indicators of air pollution and are related to the effects on animals, plants, materials and visibility.

The high-volume air sampler is an automatic instrument used throughout the United States; it is presently the recommended device for particulate sampling of large volumes of air. The principle of operation is to filter large volumes of air through a porous filter by the use of a vacuum motor providing suction. Though automatically operated, the manual function of collecting the sample for laboratory analysis must still be performed. High volume monitoring devices are usually located in areas where an average of concurrent measurements can provide a fairly precise indication of the mean concentration for an urban area. The location should be clear of local air pollution sources that would bias the sample.

The instrument designed for low volume air sampling and recommended for monitoring soiling index is widely known and used in air pollution control programs. This is an automatic device utilizing the principle of filtration: a reciprocating pump pulls air through a one inch diameter area of filter paper leaving a spot of that same dimension after a preselected automatic time interval of anywhere from two minutes to three hours in length. Either of two evaluation methods can be used based on transmittance of light through the spot.

(2) Gaseous Monitoring

Gaseous pollutants can be monitored by either manual or automatic methods. Of the major manual methods, absorption is the most frequently used method for specific gas sampling of the ambient air. Absorption involves transfer of the soluble portion of the gas into a liquid medium. This method is efficient and convenient for use in sampling small volumes of gases.

Dosimetric sampling also is used frequently in air monitoring programs and involves the exposure of various reagents on collection media such as filter papers impregnated with reactive agents that are specific for gaseous pollutants. These are qualitative techniques rather than quantitative, but they provide an estimate of the concentration of gases in the air.

Automatic methods and instrumentation for monitoring and analyzing gaseous air pollutants are designed to absorb the specific gaseous contaminant in a liquid absorbing reagent. Techniques other than liquid absorption involve ionization of the gaseous molecules or direct absorption of the radiant energy of the gas. Such absorption techniques are the most common types of collection used both for manual and automatic sampling.

For the most part, automatic gaseous sampling is differentiated according to the analysis part of the method. The primary analytical methods used for monitoring gases are electromagnetic and electrochemical methods. Basically, electromagnetic methods use a source of energy to detect the amount of radiant energy absorbed by the substance to be analyzed. From this a concentration can be calculated or automatically recorded. These energies are measured in terms of wave lengths which consist of oscillating electric and magnetic fields and range in frequency from electric waves to cosmic rays. Electrochemical methods produce changes in conductivity or electrical charge following chemical reactions between pollutant gases and reagents. The electrical impulse produced, or a result of these chemical reactions, is a measure of the concentration of the pollutant sampled.

2. General Appraisal of Air Monitoring Methods

Development of the Federal government's air resource management concept has resulted in expansion of comprehensive air monitoring systems within air pollution control agencies throughout the country. Simultaneously, there has been growing concern over the validity of data produced by new techniques and instrumentation available to these agencies. Several studies have been conducted concerning the effectiveness, reliability, and validity of results obtained by monitoring methods for sulfur dioxide and particulate matter. The common conclusion has been that uniform and standardized procedures for the measurement of air pollutants should be developed. Various professional and governmental agencies such as the American Industrial Hygiene Association, the Air Pollution Control Association, the American Society for Testing and Materials, and the California State Health Department have developed and recommended standardized methods for measuring selected air contaminants. Yet much research is required to provide a foundation for better air quality measurement. Standard methods are needed on such matters as

- procedures for techniques used in calibration of automatic atmospheric analyzers and in analytical methods used for pollutants,

- practicality of laboratory field methods and instrumentation,

- interpretation of the results of sampling various air contaminants,

- conversion factors for different methods of characterizing the same air pollutant, particularly methods used by various countries.

The United States Public Health Service has promoted efforts to attain the goals through grants for the development of manuals of sampling and analysis methods and establishment of the Analytical Methods Evaluation Service. The Service's mission has been to

- develop technology for collaborative testing,

- evaluate the reproducibility of methods used to measure the same pollutant in different laboratories,

- develop optimum methods for sampling and analysis of pollutants.

Increased emphasis on standardization of air monitoring techniques and methods is the result of new governmental programs establishing air monitoring systems, with many larger state and local agencies relying on instrumentation methods for rapid retrieval of data. As air quality management programs continue to produce new automated monitoring systems, major emphasis will be placed on obtaining the required data accurately and continuously in all sections of the community or region.

The trend, particularly in interstate metropolitan areas, is to comprehensiveness in air monitoring networks. Chicago's efforts in defining the number and distribution of stations for its telemetered network represent an effective approach. Primary emphasis and concern in establishing monitoring networks in large metropolitan or regional areas centers on the validity and reliability of the measurement systems themselves. Achieving this reliability and validity requires evaluation and standardization of sampling and analytical measurement systems of both manual and automatic design types. Monitoring equipment should be evaluated as to (1) accuracy, the capability of the instrument to measure the precise concentration of the atmospheric pollutant; (2) responsiveness, the speed with which a pollutant is measured; (3) sensitivity, the smallest concentration that the technique can measure with accuracy; (4) range, the capability to measure varying differences in concentration; (5) specificity, the capability of a method to measure a pollutant without external influences altering the true value; (6) reproductability, the degree of reliability and stability of the components, reagents and apparatus of monitoring methods; and (7) flexibility, the capability of a technique to measure more than one pollutant by simple conversion techniques. Other factors such as cost, space requirements, ease of maintenance and service are also of importance.

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SECTION III

RELATIONSHIP BETWEEN AIR POLLUTION AND HEALTH*

A. Objective and Methodology

1. Background on Health Impact Research - Significance and Trends

Air pollution and its relationship to health has been a matter of concern throughout the world for many years. In general, the potential health hazard of air pollution forced itself to the attention of the public and to public officials when, because of atmospheric inversions or for other reasons, local pollution rose to unusually high levels. On such occasions very serious health problems occurred. Famous occurrences of this nature have been recorded, e. g. , the Donora, Pa. tragedy of 1948, the Meuse Valley episode, more recently several serious episodes in London, New York and elsewhere. During such episodes, which have lasted generally for two or more days, much illness occurred among the inhabitants of the region, along with a marked rise in mortality rate from respiratory, cardiovascular and other problems. Particularly affected are the aged and the ill. Investigation by governmental agencies generally followed these most tragic events, or "accidents." All of these episodes, being short-term, are classed as demonstrating acute effects, in contrast to chronic effects of long-term, low level exposure which may cause little or no ocular or other obvious discomfort.

Whether acute effects or chronic effects of air pollution on public health are in fact more serious with regard to mortality rate is conjectural at present. Acute effects are fairly well known; chronic effects are not.

People cannot miss an acute episode; their eyes may water, their throats may be irritated, the odor may be bad, and visibility is generally reduced due to haze, or "smaze" or fog. And complaints arise because of these imposed, readily detected responses. But complaints do not generally arise about the potential health hazard of long-term, low level pollutant exposure which may be essentially odorless and not particularly visible, though some haze is generally present to which the public becomes accustomed.

It is an hypothesis of this study that the long-term, chronic effects are of primary importance in understanding and controlling air pollution and its effects on health. It is therefore the objective of the health impact research to explore and, if possible, measure quantitatively the relationship between air pollutants and health as reflected by mortality rates. Government has a responsibility to protect the public from health hazards which are obscure as well as from hazards which are more easily observed. There is a great need to determine whether chronic, low levels of urban air pollution are in fact health hazards. Many questions on identification of specific health hazards exist, as well as obvious questions on what diseases are affected or induced by which specific chemicals singly or in combination.

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* The health effects studies described in this section of the Report were conducted by Dr. Richard J. Hickey and colleagues, including Mrs. E. P. Schoff, Dr. R. C. Clelland, Mrs. L. A. Tomasello, and Mrs. E. B. Harner. These studies were also supported in part by HUD grant No. H-830 to the Institute for Direct Energy Conversion of the Towne School of Engineering. This was part of a "minicar" study directed by Dr. Manfred Altman. The studies were also aided by grant No. IN-38-I of the American Cancer Society to the University of Pennsylvania, and more recently by PHS grant No. 5-SO5-FR-07083-02, also to the University.

Progress has been limited on determining the relationships of long term, low levels of pollutants to chronic disease. There is, of course, the well-known gross association of the increase of urban mortality rate for some types of cancer with the increase of urban size. The grossness of this type of association does not lead to much enlightenment in understanding of functional relationships of specific chemicals.

It is known that there is a great variety of polycyclic hydrocarbons, some of which are carcinogens, in urban air as well as complex organic nitrogen- and oxygen-containing compounds, some of which are also carcinogens. This fact is of interest, but it does not prove that they are the major cause of lung or other cancer. The large variety of organic carcinogens in the air complicates the problem considerably, as does the fact that there are also co-carcinogens and anti-carcinogens. It is known that charcoal-grilled or fried steaks which may be charred contain polycyclic hydrocarbons which are carcinogenic. Charring evidently rather generally may yield such compounds. Some people consume a variety of foods which may be charred to some degree. In addition to steak, there is charred toast, excessively-fried foods of many types, grilled sandwiches which are too well grilled, charred hamburgers, and other items.

It is known that both urban air and the cigarette smoke stream contain some chemicals which are present at appreciable or high levels in both, e. g., NO_2, CO and polycyclic carcinogenic hydrocarbons.

Several persons have expressed opinions that a number of environmental chemicals must be involved simultaneously in disease processes, e. g., Kotin, Gardner, Anderson, Nelson and others. Most published studies involving correlation involve bivariate relationships, i. e., one disease rate versus one pollutant concentration or pollutant category. Correlation coefficients are given and/or bar graphs are drawn. These are effective indications, but do not come to grips with the multivariate problem, i. e., the prospect, or reality, that a number of chemicals and other variables may act simultaneously to induce or to influence disease.

Multivariate statistical methods exist which are capable of handling many variables simultaneously. However, realistic concepts or hypotheses are necessary regarding what constitutes an ecological system of man and his environment, or an approachable portion of the environmental and other variables of the system and how they may affect man. Since multivariate statistical methods are available, which require computers for data analysis, hypotheses concerning human ecological systems should be tested for validity. The analyses may in part provide indications of the validity of the hypotheses.

It is possible that there has been excessive preoccupation with smoking effects on health and with studies on some of the better-known polycyclic carcinogenic hydrocarbons to the detriment of a broad ecological approach to the question of the relationship of environmental chemicals to chronic diseases generally. This point has been made by Lawther, who said that "'classic' carcinogens such as 3, 4 benzopyrene may have claimed too much attention in recent years to the detriment of the search for more sophisticated mechanisms by which lung cancer may develop." Also, excessive preoccupation with smoking and lung cancer may have been occurring to the detriment of broad studies in human ecology and of the varied factors acting together which may relate to the origin in general of malignant disease and other chronic diseases such as cardiovascular diseases.

2. Basic Hypothesis and Methodology for this Research

In attempting to approach the problem of determining the relationships between environmental chemicals and non-infectious, chronic diseases the well-known fact that the rate or frequency of occurrence of these diseases increases with age was recognized. Vital statistical data show, for example, that mortality rates for various categories of cancer and for cardiovascular diseases generally increase with increasing age.

It is rather widely believed that aging progresses physiologically through a gradual accumulation of mutations at the cellular level, which occur through modifications of the DNA code and are reflected in modified cell characteristics. Since non-infectious chronic diseases are age-related and since radiation has been reported to induce responses rather like effects of aging, and since radiation is strongly mutagenic, it seemed reasonable and possible that there may be environmental chemicals which might have mutagenic or radiomimetic properties and thus influence the rate of development of certain chronic diseases or hasten the appearance of certain types of cells such as, for example, malignant cells.

It was therefore decided to examine the relationship between environmental chemicals and chronic diseases, hypothesizing that environmental concentrations of certain of these chemicals may be positively correlated with chronic disease mortaility rates, and that the mechanism might be explained on a molecular genetic basis, i. e., that certain specific air pollutants may be able to alter cellular DNA, i. e., the genetic code. Some radioactivity exists in the environment and may cause some mutations at a very slow rate. However, some relatively simple chemicals are also mutagenic. One particularly strong one is nitrous acid, a weak acid, which may attack DNA or RNA by a deamination reaction. Permanent errors or modifications of the genetic code may be introduced and accumulate over time. Nitrous acid is derivable from NO_2 (or N_2O_4), which is ubiquitous in urban air, and arises from a number of sources including automotive exhaust. NO_2 dissolved in water yields one molecule of nitric acid (HNO_3) and one molecule of nitrous acid (HNO_2). In body fluids or cells, with a few exceptions, the pH is near neutral, so the acids are neutralized. Salts of nitric acid, a strong acid, would be expected to yield little molecular HNO_3 in neutral soft tissue or blood. But salts of nitrous acid, a weak acid, would be expected to yield HNO_2 to some extent, which could attack DNA. The probability of HNO_2 or nitrite deaminating nucleic acid is related to the HNO_2 or nitrite concentration and to the exposure time. Also, under more acid conditions, a nitrite would yield HNO_2 in greater proportion to the neutral form and the risk of DNA deamination might be expected to increase. Gastric conditions are acid.

In addition to atmospheric NO_2, other atmospheric chemicals are also ubiquitous, such as SO_2, CO, NO, oxidants, polycyclic hydrocarbons and hydrocarbon derivatives, and other chemicals, such as various metals, some of which are considered toxic. Environmental chemicals affecting man also occur in his drinking water, his food, and his medicines. The man-environment ecological system thus involves many chemical variables. It also involves weather variables, demographic variables such as age, radiation variables, psychosocial variables, smoking and drinking variables and many others. In such a complex system, attempts to evaluate the effects of a single environmental variable on human health without considering its effect jointly with other variables seem unrealistic.

The problem appears to be clearly and truly a problem in which many potentially "causal" variables may be involved in the induction of many health and other effects. The problem, then appears to fall in the field of multivariate analysis. This is an advanced, specialized field of statistics which can handle large sets of data for many variables simultaneously. Causal variables are called "predictors," and responses or diseases are called "criteria."

For the air pollution - health problem, multivariate analysis requires input data for many communities, preferably over 30, for all predictor and criteria variables.

Multivariate analyses can determine significant multiple relationships between each criterion and the predictors, and select the significant predictors. Multiple regression equations will be derived in which a mortality rate is predicted in terms of environmental concentrations of several chemical predictors. This procedure should be applicable to both acute and chronic diseases.

Studies have shown, thus far, that the multivariate statistical methods function effectively for studies on chronic diseases. The findings are described in a subsequent section. The reliability and validity of statistical inferences are enhanced if support is obtained from other disciplines such as biochemistry and physiology. To some extent, such support has been found. Further study is necessary, however, to demonstrate cause and effect. In general, determination of local limits of pollutant concentrations in cities varies widely from city to city, and from country to country. In the absence of clear indications of the dangers of long term exposure to subacute levels of atmospheric chemicals which do not obviously irritate or aggravate people, limits are based to a large extent on acute effects, such as ocular and respiratory irritation and odor. Since such discomfort is generally temporary, with long term effects not necessarily evident as presenting really dangerous risks, except during inversions or other temporary high pollution periods, no great concern is expressed by the public or by public officials. Stringent controls are not imposed except on "bad" days. Subacute, long-term levels of SO_2, NO_2 and other chemicals in the air are not considered particularly harmful.

The establishment of serious risks to health from chronic diseases resulting from long-term exposure to subacute levels of air pollutants could require radical revisions in regulatory procedures. It has been found indirectly that long-term exposure of man to subacute levels of certain atmospheric chemicals is associated with mortality rates for a number of very serious chronic diseases, such as cancer, heart disease and stroke. The details are provided in the following section. These details include multiple regression equations and graphical representations of the disease responses which might be expected for variations in concentrations of individual significant chemicals while holding others constant.

One final word should be said regarding the hypothesis and methodology used in these studies. Both the hypothesis and methodology presuppose the existence of an orderly universe rather than a chaotic one (5). In examining the results of the study, it is well to contemplate what might be expected from the analysis of large sets of chaotic, unordered data as compared with analysis of sets of data from an ordered system. If the biological universe is chaotic, data from it should be chaotic. If the biological universe is orderly, even highly complex sets of data involving many simultaneous relationships should be, in the main, orderly. Hypotheses stating the existence of certain types of order should be testable. The present multivariate analyses culminate in tests of the validity of hypotheses concerning the structure of such a system.

One must, of course, distinguish between analysis and synthesis in examining complex ecological systems - in the present case the ecological system of man and his environment. An attempt to synthesize conceptually an ecological or other biological system, presupposes knowledge of the many facets of the system and does not carry within it a mechanism for discovering novel and perhaps surprising relationships which may in fact exist. The synthesis will depend on the knowledge, insight and also the biases of the synthesizer.

On the other hand, if one attempts to analyze an ecological system, data may be included which reflect knowledge, insight, and previous testing. Hopefully, other data will be used which reflect the analyst's acknowledgement that heretofore unknown relationships may exist. This does not really seem so different from the work of the organic chemist or biochemist who isolates a new, biologically highly active compound in highly purified crystalline form. He wishes to know its organic structure so the compound can be synthesized to avoid expensive, laborious extraction from natural sources. He subjects the crystalline product to physical, chemical and other types of analyses, which are well known, in order to arrive eventually at a detailed, authentic structural representation of the compound. However, a further test is necessary. The analyst now proceeds to synthesis of the structure. The new synthetic product, if it is identical with the natural product, must demonstrate the same biological, chemical, and physical characteristics. Analysis, therefore, is absolutely essential and fundamental.

In ecology, likewise, analysis should precede synthesis. The synthetic ecological system should yield the relationships expected if it is to be a usable model. Models of ecological systems are very complex, involving multiple feedback mechanisms, toxic chemicals, beneficial chemicals, chemicals which may substitute for others in some mechanisms, either innocuously or deleteriously; chemicals which may be involved in many biological reactions (certain trace metals, for example); chemicals which are essential at low levels and toxic at high levels; and even, perhaps, chemicals which might be simultaneously beneficial in one capacity and toxic or dangerous in another. With such concepts and considerations in mind, experimental studies may be undertaken.

B. Findings of the Multivariate Statistical Studies Demonstrating the Health Impact of Air Pollution*

1. Basic Conclusion

In the health effects research performed to date, considerable confirmation of the general hypothesis concerning relationships between environmental chemicals and chronic disease mortality rates has been demonstrated. The relationships are multivariate and are based on data measured and reported for a substantial number of communities throughout the United States. Statistically significant relationships have been found between measured concentrations of identified environmental chemicals and mortality rates for major categories of cancer, cardiovascular diseases, vascular diseases of the central nervous system (stroke), and congenital malformations (birth defects) in 38 communities of varying size. The 38 communities represent Standard Metropolitan Statistical Areas which encompass Philadelphia and nine of the ten largest cities in the United States. Collectively, the total population of the SMSA's included in the health effects analysis exceeded 60 million people in 1960.

2. The Data

The data used for analysis were obtained from annual volumes of vital statistics publications of the Public Health Service. The air pollution data were also largely from publications of the Public Health Service, though some information was requested and obtained from local and state sources. The basic data used in the analysis are available upon request to the Government Studies Center.

For analysis, it is most desirable that a matrix of data be completely filled. For an initial study, data on 11 pollutant variables and mortality rates for 10 disease categories for 38 Standard Metropolitan Statistical Areas (SMSA) in the United States were subjected to multivariate analysis. This involves a data matrix of 21 variables for 38 communities, that is, a 21 x 38 matrix containing 798 items of data. Most of the individual items are means of two to six annual measurements. Some few items, however, are based on single annual values. In five instances no data were available, so values were estimated. Annual means were used since it was found that annual mean pollutant concentrations and mortality rates for specific chronic diseases are fairly constant for individual communities from year to year. This was discussed in the section on rationale in reference (4) and elsewhere in this report. It seems unlikely that the five missing elements would influence the results reported to any perceptible extent, though some minor modifications in equation constants may occur.

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* In addition to the detailed description of findings presented in this report, further discussion, analyses, and background information are contained in a number of documents prepared during the study. The documents include Progress Reports dated November 30, 1967 (1), and February 29, 1968 (2), in a special interim memorandum of May 20, 1968 (3), and in a manuscript on findings, relating particularly to air pollutants and cancer, which was submitted during May, 1968 to a journal for consideration for publication (4). All of these documents were earlier submitted to appropriate officials in the US Public Health Service for review and discussion.

It is realized that both the mortality and pollutant data may well contain errors and biases. The recorded cause of death may be erroneous in some cases. Or the causes may be multiple, but only one cause might be recorded. Also, diagnostic problems may result where autopsies are not permitted. In general, however, it is presumed that diagnoses by the medical profession are as precise as conditions permit, and are sufficiently accurate, in general, so that the data are suitable for analysis. A requirement of data "perfection" is unrealistic. Similarly, it is presumed that air pollutant measurements, though imperfect, may be sufficiently accurate to justify the procedure. To presume otherwise is to suggest that collection of pollutant and vital statistical data is a waste of time and public funds. If orderly results are obtained, the order will suggest that original data showed some degree of accuracy.

The overall investigation embodying the air pollution - health studies is complex and lengthy. For the sake of an orderly research and presentation plan, the investigation has been subdivided into separate component studies which are listed below. The studies listed are either completed or in progress. Additional studies on the relationship between air pollution and acute diseases are contemplated.

Study I: "Relationship Between Air Pollution and Certain Chronic Disease Death Rates. Multivariate Statistical Studies." This study dealt with methods and was published in the Archives of Environmental Health, Vol. 15, pp. 728-738 (1967).

Studies II through V: These studies have the same general title, but different subtitles. "The Relationship Between Air Pollution and Chronic Disease Death Rates.

II. Cancer and Respiratory Disease."
III. Cancer at Specific Sites."
IV. Cardiovascular Diseases and Stroke."
V. Congenital Malformations."

Study II has been written and submitted to a journal. Studies III, IV, and V are in preparation.

3. The Relationship between Air Pollution and Chronic Disease Death Rates: Cancer and Respiratory Disease; Study II

The pollutant variables studied were cadmium (Cd), copper (Cu), lead (Pb), manganese (Mn), nickel (Ni), tin (Sn), vanadium (V), zinc (Zn), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and particulate sulfate ($SO_4^=$) for 38 communities in the United States. Measurements were in $\mu g/m^3$ of air. The disease categories, of a respiratory or respiratory-related nature, are largely chronic and non-infectious, with a few exceptions. These disease categories, given as mortality rates in deaths per 100,000 persons per year, are lung cancer (160-164)*, bronchitis (500-502), other bronchopulmonic diseases (525-527), gastrointestinal cancer (150-156A, 157-159), asthma (241), diabetes mellitus (260), pneumonia (490-493), chronic nephritis (592-594), respiratory tuberculosis (001-008), and the general malignant neoplasm category (140-205). Means, standard deviations, and correlation matrices were obtained using pollutant concentrations transformed to their natural logarithms.

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* The parenthetical numerical specifications are according to the Manual of the International Statistical Classification of Diseases; Injuries and Causes of Death, 1955 Revision, World Health Organization, Geneva, 1957.

The multivariate methods used were canonical analysis and multiple correlation analysis (4). These methods in general reinforced each other. Canonical analysis indicated that there were probably relationships between pollutants and cancer, and suggested what the important chemicals might be. Multiple correlation analysis confirmed this and yielded multiple regression equations which indicated the significantly associated chemicals and whether they were directly or inversely correlated. They also yielded quantitative linear relationships between concentrations of the significant chemicals and mortality rates. The equations were considered prospectively general for the 38 communities, and possibly for others. The results were statistical and did not, of course, prove cause and effect. However, support from other disciplines is noted later.

In brief, stepwise multiple correlation analysis yielded a series of equations leading to the final one for each disease, and for the pollutants previously indicated.

The following notation was used:

M_1 = lung cancer mortality rate in deaths per 100,000 persons

M_2 = gastrointestinal cancer mortality rate in deaths per 100,000 persons

M_3 = total cancer mortality rate in deaths per 100,000 persons

$c(Cu)$ = atmospheric concentration of copper in $\mu g/m^3$

$c(NO_2)$ = atmospheric concentration of NO_2 in $\mu g/m^3$

$c(SO_2)$ = atmospheric concentration of SO_2 in $\mu g/m^3$

$c(SO_4^=)$ = atmospheric concentration of particulate $SO_4^=$ in $\mu g/m^3$

The most significant relationships found involved cancer. The best predictions for the several categories are given in Table 3. The qualitative predictors are shown along with the quantitative relationships based on analysis of the data. In this first cancer study, concentrations of sulfate and copper were found significant for lung cancer, while SO_2, NO_2 and copper were found significant for gastrointestinal and for total cancer mortality rates. Joint tests of significance were run at all necessary points to establish that the contribution of the added predictor to variance reduction was significant at the $\alpha = 0.10$ level at most. The significance level was usually $\alpha = 0.025$ and occasionally $\alpha = 0.01$.

An example of a multiple regression equation derived from Table 3 is Equation 5, which gives the best linear prediction of gastrointestinal cancer mortality rate based on three variables, taken from the pollutants used in this study.

$$M_2 = -61.54 + 8.809 \ln c(SO_2) + 13.47 \ln c(NO_2) - 6.925 \ln c(Cu) \qquad \text{(Eq. 5)}$$

The multiple coefficient of determination, R^2, is 0. 57 for this equation, as shown in Table 3. This indicates that about 57% of the variance is accounted for in the prediction of the criterion, M_2.

It should be noted that $SO_4^=$, SO_2, and NO_2 are positively correlated with the mortality rates shown in Table 3. This carries a toxic or deleterious implication, while copper is, in all cases, negatively correlated. The implication is that copper is protective or beneficial, i. e. , the higher the concentration of copper, the lower the cancer mortality rate.

Sulfur dioxide and NO_2 are hypothesized to exert their deleterious effects through their mutagenic or radiomimetic properties. NO_2 is known to yield nitrous and nitric acid in aqueous solution, or nitrite and nitrate in buffered solutions. Nitrous acid is a powerful, well-known mutagen. Sulfites or bisulfites are not so well known as mutagens, but some evidence indicates that they may be radiomimetic (4). A complex nutritional relationship is known to exist between copper, the sulfate radical and molybdenum (2, 4). Increases of dietary $SO_4^=$ are known to reduce body or cell retention of copper. Lowered copper has been associated with increased cancer rates in some reports. Environmental molybdenum data were inadequate for analysis. Whether there are relationships between these observations remains to be determined.

After determining chemical predictors for the three cancer categories, it was found to be possible to obtain complete data for several other U. S. communities for the few significant chemicals. This allowed substitution of these new communities for the few for which some data were missing. Following substitution, multiple correlation analyses were run on two new sets of data, known as the "Salt Lake City set" and the "Portland set," in addition to the "original set." The resulting equations were similar both to each other and to the initial run.

Tables were prepared for the above three sets of data in which the equations were used to predict mortality rates for the various communities. The predictions were compared with actual rates, and deviations were recorded (4). It was found that fairly large negative deviations occurred for Salt Lake City, i. e. , the actual cancer rates were appreciably lower than predicted rates based on air pollutant data. Salt Lake City, therefore, seemed somewhat anomalous, particularly for lung cancer.

It was recalled that Salt Lake City is the center of the Mormon religion. The use of alcoholic and certain other beverages are not approved by that religion, nor is smoking. Data on tobacco consumption supports the view that Mormon principles are significantly involved, i. e. , tobacco consumption is in fact low in Utah. Salt Lake City was therefore considered to be atypical as compared with most other cities in the United States. The "Portland set" was therefore prepared in which Portland, Oregon, replaced Salt Lake City. It was found that the Portland set gave results quite similar to those of the original analysis.

On the basis of the statistical findings, along with supporting information from biochemistry, physiology and molecular genetics (2, 4), a general hypothesis was developed to account for the findings. It is hypothesized that NO_2 and SO_2 yield, on solution, absorption, and dispersion throughout the body, radiomimetic compounds which bring about an accumulation of errors over time in the DNA code of the various cells. This presumed radiomimetic action would simulate the effect of radiation. If this is so, aging effects should be involved along with the development of certain chronic diseases whose frequency rates in populations increase with age. Such diseases include cancer and circulatory diseases, among others.

Nitrous acid, which may appear very infrequently through dissociation of the weak acid-weak base derivative, is known to deaminate appropriate sites on DNA, leading to code errors. The mechanism of chemical mutagenic action of sulfite or bisulfite is, at present, unclear (4). The protective mechanism of copper also is not clear, but it might chelate or otherwise form a derivative with primary amine groups on DNA and protect them from deamination by nitrous acid. Further study is necessary here.

At any rate, the mutagenic or radiomimetic hypothesis requires that the accumulation of DNA code errors could not be limited to cancer-related or carcinogenic DNA error accumulation. It must be general. It should follow, therefore, that SO_2 and NO_2, individually or jointly should also occur as positively correlated predictors for certain other chronic diseases, such as cardiovascular diseases, vascular diseases of the central nervous system (CNS), and, though it might not be considered a disease, aging. In addition, if there really is a DNA code alteration mechanism, the action should be detectable, perhaps, in a change in frequency of certain diseases of a defective developmental nature, such as congenital malformations (birth defects).

The studies which follow are not yet completed, and results are preliminary and not fully evaluated. Findings are therefore subject to re-evaluation, and inferences to modification. They are provided because of their interrelated significance which tends to allow support for the general hypothesis concerning the accumulation of DNA code errors. One study bears further on cancer and carcinogenesis, and others are concerned with cardiovascular diseases, vascular diseases of the CNS, and birth defects. All may be related through a common etiological mechanism. All may well have a molecular genetic basis of development and, in the case of cancer, of initiation, and all appear to be influenced by environmental chemicals.

4. The Relationship between Air Pollution and Chronic Disease Death Rates: Cancer at Specific Sites; Study III

In Study II it was found first that there were primary relationships between concentrations of some air pollutants and mortality rates for lung cancer and gastrointestinal cancer. Since these two types of cancer appeared to be associated with pollutants, it was decided to examine the relationship between air pollutants and mortality rate for all types of cancer combined for the 38 SMSA's to see if the cancer relationship might be general. The analytical results, as shown in Table 3. indicate that such a relationship exists. It therefore seemed appropriate to carry out a fairly detailed study concerning the relationships between air pollutants and cancer at specific sites. This was done and is the basis for Study III which concerned cancer exclusively.

For initial studies, 7 cancer categories were used and 13 environmental chemical variables. Some additions and deletions in the group of environmental chemicals used in Study II were made in Study III. The environmental variables used for analysis were atmospheric concentrations in $\mu g/m^3$ of cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), nickel (Ni), tin (Sn), titanium (Ti), vanadium (V), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and particulate sulfate ($SO_4^=$). Also included was hardness of drinking water in the communities involved, expressed as ppm of calcium carbonate. This last was included because of reports in the literature that rates of occurrence of certain cardiovascular diseases were lower in cities with harder water than in cities with softer water. The question to be considered was whether this effect could be detected by multivariate statistical procedures, and whether it might be related rather broadly to frequencies or mortality rates for certain chronic diseases other than circulatory diseases.

The environmental chemical variables are the predictors. The criteria are means, overtime, of mean annual mortality rates per 100,000 persons in the individual communities for different categories of cancer, i.e., lung (160-164), upper respiratory system (140-148), urinary organs (180-181), genital organs (171-179), gastrointestinal system (150-156A, 157-159), breast (170), and leukemia-aleukemia (204), covering the four year period, 1961 through 1964.

Significant relationships have been found in all cases, however, it is desired to refine the data by considering the sexes separately. It is also intended to do this for cancer of the urinary organs. Breast cancer is to be analyzed in terms of the female population only, and the results compared with the present findings for the entire population.

In addition to the 7 cancer criteria variables and 13 environmental chemical predictor variables, one further variable was examined after the stepwise multiple correlation analyses had been run. This added variable was the median age of the populations of the various communities (8). This variable was considered last for significant reasons which are discussed below.

First, in Table 4 are presented multivariate analytical findings for the lung cancer (ICD 160-164) criterion. Several chemical predictors not involved in Study II appeared significant in this study. These are titanium (Ti), chromium (Cr), and hardness of water (HW). Sulfate and copper, found significant in Study II, were also found significant in Study III, with $SO_4^=$ positively correlated and copper negatively correlated as before. Of the new, added chemical predictors, hardness of water is positively correlated, as is chromium, while titanium is negatively correlated. The coefficients showed little change. We note that chromium has been implicated previously as being associated with increased cancer rates (10,11).

The inverse or negative relationship of titanium is of interest. It appears to be protective. Titanium oxide has been used rather widely in house paints in recent years as a white pigment, in place of lead oxide. A preliminary check of the literature concerning titanium has not been particularly enlightening, though it is reported (25) to inhibit the oxidation of cysteine to sulfonic acid. Considerable library research is necessary. The positive relationship of water hardness is also surprising, and is the reverse of reported relationships to vascular diseases.

The five environmental variables yielded an R^2 of 0.63, indicating that about 63% of the variance in the prediction of the criterion is accounted for. The corresponding coefficient of correlation, R, is 0.79. Related data are given in Table 4.

At this point, an added study was made to examine the effect of using median age for the communities involved as an added predictor variable (8). It was used in this trial study without transformation. Observation of data on individual deviations for the communities and their median ages indicated that inclusion of this variable should reduce the variance. This was found to be true, as shown in Equation 7 of Table 2. The median age for communities varied from 22.5 for El Paso to 35.8 for Scranton, Pa. Inclusion of this variable led to an R^2 of 0.75, implying that 75% of the variance in prediction of the criterion is accounted for, with a multiple correlation coefficient, R, of 0.87. Inclusion of age in this study did not change the coefficients much.

Since lung cancer is a chronic disease whose frequency is known to increase with age, the above findings for the age variable seem reasonable. They also show by analysis that age, as expected, is a significant, positively correlated predictor. It should be noted that neither NO_2 nor SO_2 appear as significant predictors for lung cancer in this particular analysis. * The question is being studied further, particularly regarding aging.

Because of the early nature of the cancer findings and the lack of time for full evaluation and study, only a few additional findings will be given, and these briefly. They are shown in Table 5. Detailed progressions of equations, as shown in Table 4, are available for all categories.

a. Gastrointestinal Cancer

As shown in Table 5, the availability of other chemical predictors for gastrointestinal cancer (150-156A, 157-159) did not result in any change of the predictors from those obtained in Study II. The predictors are still SO_2, NO_2 and copper, with copper negatively correlated. The regression equations are quite similar to those of Study II.

When median age was included, R^2 rose from 0.57 to 0.785, and R rose from 0.755 to 0.89, with corresponding statistics as shown in Table 5. Age was positively correlated, as expected. It should be noted that when age was introduced as a variable the coefficients for the $\ln c(SO_2)$, $\ln c(NO_2)$ and $\ln c(Cu)$ terms were all reduced appreciably. It may be advisable to stratify the original data by age groups and sex initially and then run regression equations on these segments of data. Sample sizes must be adequate, of course.

Senescence is the physiological process of aging. While it increases with time it is not necessarily proportional to time alone and varies widely between individuals. It might be expected that any age group of either sex would age more rapidly physiologically in a highly polluted area than in an area with low pollution levels. In epidemiological studies involving environmental pollutants which may accelerate aging, one should consider physiological as well as chronological aging. It may be possible that, for example, men in the chronological age 60 to 65 bracket in a highly polluted area may physiologically closely resemble older men in areas with cleaner air. Also, more individuals in the highly polluted area may have died of chronic diseases.

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* Very recent studies indicate that atmospheric SO_2 and NO_2 concentrations are probably associated with lung cancer mortality rates.

b. Cancer of the Upper Respiratory System (ICD 140-148)

Limited, preliminary data on findings are given in Table 5. The significant chemical predictors were found to be particulate sulfate and titanium.

This analysis, using mortality rate data for upper respiratory system cancer, yields two predictors, $SO_4^=$ and Ti, already found to be significant for lung cancer. Again, SO_2 and NO_2 did not appear, thus far, as with lung cancer. The consistency of these findings would seem to be more than coincidental. In addition, $SO_4^=$ is positively correlated, as with lung cancer, and Ti is negatively correlated, also as with lung cancer.

Again, when median age was added as a predictor variable, it reduced variance significantly, raised R^2 from 0. 43 to 0. 52, and raised R from 0. 65 to 0.72. The magnitude of the coefficients for $\ln c(Ti)$ and $\ln c(SO_4^=)$ was appreciably reduced. Interpretations regarding use of the age variable should be reserved.

c. Cancer of the Genital System (ICD 171-179)

This was a preliminary study using available vital statistics in which the data were not separated by sex. It is intended to run similar analyses for each sex subsequently. It will then be possible to determine whether this separation for analytical purposes is important ecologically.

The findings of this preliminary study are of interest. In Equation 5 of Table 5, which involves chemicals only, the significant predictors are SO_2, NO_2 and copper. SO_2 and NO_2 are positively correlated and Cu is negatively correlated. These three chemicals were selected by multiple correlation analysis from a group of 13 available environmental chemical categories. These same three had previously been found significant for gastrointestinal cancer (and total cancer). The probability of qualitative duplication twice in a row is quite low. Since a positive (+) or negative (-) sign is also involved for each predictor, there are then 26 options. A particular three, not just any three, were selected twice in a row using two different sets of mortality data. The chance of this happening at random is $[(1/26)(1/25)(1/24)]^2$ or about once in 240, 000, 000 attempts. It is like having an urn containing 3 black and 23 white marbles, and selecting the 3 black ones in two consecutive trials. Moreover, NO_2 and SO_2 recur as significant predictors for other types of cancer and for other chronic diseases as well.

As with gastrointestinal cancer, the median age vaiable was then included, as noted in Table 5. Inclusion of the age variable again reduced variance significantly and increased R^2 from 0. 26 to 0. 41 and R from 0. 51 to 0. 64, as shown in Table 5.

In addition, however, as was found for gastrointestinal (GI) cancer, but not for lung cancer, inclusion of the age variable strongly reduced the coefficients for the chemical predictor variables. It reduced the coefficient for the $\ln c(SO_2)$ term so much that it became negative! This is considered unrealistic. It is strongly suspected that there is interference between age as a variable and the radiometric or ageing effect of the chemicals, SO_2 and NO_2. Further study is necessary. However, analysis of data on age groups, e. g. , males, aged 45 to 55, and not adjusted data, should yield more definitive information if sample sizes are large enough. This has not yet been attempted; considerably more evaluation is necessary, and modified procedures are necessary for handling age and aging.

Regarding interference between age as a variable and ageing agents, it should be noted, for example, that radiation dose is a function of the intensity and the exposure time. Exposure to radiomimetic chemicals should also be a function of intensity of exposure and of exposure time.

d. Cancer at Other Sites

Analyses have been run using the 13 environmental variables for 38 communities against other cancer mortality rate criteria. Because evaluation and further analyses are still in progress, the results are not detailed here. It may be mentioned, however, that ln c(NO_2) and ln c(SO_2) recurred as significant predictors for mortality rates for breast cancer, and cancer of the urinary system. Some metals appeared as significant predictors for certain cancer types, but these findings must be evaluated further. For example, nickel appeared as a positively correlated predictor for leukemia-aleukemia, but at a rather low level of potential importance. Nickel has been reported elsewhere to be carcinogenic (9, p. 343; 10, 11).

5. Relationship between Air Pollution and Chronic Disease Death Rates: Heart Disease and Stroke, Study IV

Another group of multivariate statistical findings concerns relationships between 16 environmental chemical concentration predictor variables and mortality rates for several categories of cardiovascular disease, and for vascular diseases of the central nervous system (CNS), i. e., stroke. The studies are still in progress and evaluation of findings is continuing. While positive results were obtained, inferences must be made with great caution. This is in part because some of the findings and inferences may be in conflict with some conventional views. These matters are to be considered in later studies.

A highly condensed set of findings is shown in Table 6. These findings provide the multiple regression equation coefficients, along with some other statistics. Joint tests of significance were run to determine whether the contribution of each added variable reduced variance in the prediction of the criterion significantly. The variance reduction was significant at $\alpha = 0.10$ or less in all cases.

There were 16 environmental chemical predictors used in the studies, and 9 categories of mortality rates of diseases of the circulatory system, in particular cardiovascular diseases and stroke. The environmental chemical data were for mean annual atmospheric concentrations in $\mu g/m^3$ of Cd, Cr, Cu, Fe, Pb, Mn, Ni, Sn, Ti, V, Zn, NO_2, SO_2, $SO_4^=$, and As, along with hardness of drinking water (HW) for each community in ppm of $CaCO_3$.

Mortality rates for the following few chronic diseases are given. The parenthetical numerical specification is according to the 1955 Revision of the International Statistical Classification of Diseases.

Arteriosclerotic heart disease including coronary disease (420)
Diseases of the heart (400-402, 410-443)
Vascular lesions affecting the CNS (330-334)

Other disease categories of the circulatory system have been examined, but findings are too recent to discuss in detail here. The diseases of the general study are largely in non-overlapping categories, with one exception; arteriosclerotic heart disease is included in diseases of the heart.

In examining Table 6, it should be recalled that the general molecular genetic hypothesis which evolved from the cancer studies (2, 4) propounds that if radiomimetic and related chemical actions on DNA lead to a slow accumulation of code errors, to a large extent a limited few chemicals should be involved in some other chronic diseases, and should recur as significant predictors, in particular SO_2 and NO_2. If these do in fact yield radiomimetic compounds when dissolved.

As indicated in Table 6, it is evident that SO_2 and NO_2 do in fact appear as significant predictors for mortality rates for the vascular diseases specified, i. e., arteriosclerotic heart disease and the broader category, diseases of the heart. NO_2 appears as a predictor for stroke. Other predictors also appear.

In this study of 16 predictors, there are 32 options when it is considered that the coefficients for each predictor may be either positive or negative. Considering further the analogy with the urn of black and white marbles, this time there are 30 white marbles and two black ones - representing positively correlated SO_2 and NO_2, which were significant for cancer. They are also significant for arteriosclerotic heart disease and for diseases of the heart. Thus in one attempt, both black marbles were selected again. Considering just GI cancer, cancer of the genital system, and arteriosclerotic heart disease, and SO_2 and NO_2 as predictors, these two "black marbles" were selected three times in a row. The chance of this happening at random is (1/26)(1/25)(1/26)(1/25)(1/32)(1/31), or about one time in 420, 000, 000 attempts. But NO_2 also appeared for stroke. And copper occurred for stroke, and was negatively correlated! And $SO_4^{=}$ appeared for diseases of the heart, positively correlated as it had occurred for lung cancer. The system does appear to show strong signs of order.

Furthermore, reports in the literature indicate that death rates from some circulatory diseases are inversely related to the hardness of drinking water (13, 14), i. e., the harder the water, the less frequent the diseases. In Table 6, it is evident that for arteriosclerotic heart disease and diseases of the heart categories -- the former is contained within the latter -- hardness of water is a significant predictor, and it is negatively correlated in accordance with the literature.

As a further note on vascular lesions of the CNS, copper is found to be negatively correlated, as with cancer, but vanadium also appeared, and it too is negatively correlated. It is very interesting to note that vanadium has been reported (9, p. 355) to depress the level of cholesterol in blood and plasma, i. e., increasing vanadium concentration decreases cholesterol. Vanadium depresses cholesterol biosynthesis and increases the oxidation rate of phospholypids, according to some reports. Vanadium, however, is not limited to this type of physiology. It stimulates the mineralization of bone and teeth in animals and prevents caries (26). In addition, vanadium salts are known to catalyze the oxidation of serotonin and L-epinephrin, among other chemicals (27).

In the stepwise multiple correlation analyses for cardiovascular diseases of several types, vanadium has appeared significant in some circumstances, but not in the set of predictors yielding the greatest reduction in variance. In some cases it was positively correlated, as had been noted in a previous, preliminary report

(15) on methodology. These new findings on mortality rates from vascular diseases and their relationships to environmental chemicals require considerable further analyses and evaluation. The system is highly complicated, as expected, but it appears orderly. The general hypothesis of the accumulation of DNA code errors through presumed radiomimetic chemical action of derivatives of SO_2 and NO_2 along with effects of other chemicals, leading to progressive degenerative diseases such as cancer and cardiovascular diseases, still appears reasonable. In fact, fairly substantial evidence in support of the hypothesis seems to be accumulating.

Comments should be made on the relationship of median age to reduction of error variance, alteration of coefficients in the multiple regression equations of Table 6, and on the use of median age as an additional significant predictor for mortality rate for certain vascular diseases. Once again, the age variable is positively correlated, as expected, and appears highly significant, especially in the two heart disease categories of Table 6.

It is important to note that for vascular lesions of the CNS, the inclusion of the age variable reduces error variance but not by so much as for the cardiovascular disease categories of Table 6. For the former, the coefficients did not change much when age was included, but for the latter, the coefficients for the SO_2 and NO_2 expressions were greatly reduced in an absolute sense, while others were also reduced but less radically.

Aging may be due, at least in part, to the accumulation of errors in the DNA code. Radiation and radiomimetic chemicals cause accelerated aging, perhaps by inducing DNA code errors. If SO_2 and NO_2 separately or jointly have radiomimetic effects, they could be expected to cause accelerated aging. The inclusion of an age variable might then be expected to result in interference. Accumulation of accidental DNA code errors could be expected to occur regardless of environmental variables; but in the absence of environmental mutagens, physiological aging might well be slowed and concomitantly the rate of development of chronic, degenerative diseases might be reduced.

In order to avoid the possibility of interference, it would appear preferable to use equations which do not contain an age variable for biochemical evaluation and interpretation. The effects of age can be investigated by examining data from stratified population groups, for instance males 45 to 55, from various communities. A problem can occur, however, if sample sizes are too small to be accurately representative. Aging might also, of course, be considered as a disease.

6. The Relationship between Air Pollution and Chronic Disease Death Rates: Congenital Malformations; Study V

The relationships between environmental chemicals and mortality rate for congenital malformations, i. e., birth defects, will be noted only briefly since considerable evaluation and further research is needed. Again, it must be cautioned that interpretations must be made with great care. Findings might be considered unconventional, but the important question concerns whether the analytical indications are pointing to biological reality.

The analyses of birth defects were run in conjunction with the studies on diseases of the circulatory system, using the same environmental chemical variables and communities. The results of stepwise multiple correlation analysis are shown in Table 7.

Studies have not progressed far enough to attempt, as yet, to explain the statistical findings. Some biochemical information is available, but it has not yet been evaluated adequately, nor has the literature in biochemistry and physiology been adequately examined. It might be noted, however, that zinc deficiency is known to cause growth retardation in the mammal (18). Information stored in DNA is used by RNA as instructions for making protein. Zinc is thought to be involved in the synthetic process leading from RNA to protein (21), and it may also be an integral part of the RNA or DNA molecules adding to their stability (19, 21).

Quite interesting is the finding that median age as a variable is inversely correlated with the mortality rate. This might suggest that the mortality rate for the malformed would be higher among the younger population groups. This appears reasonable, and on extrapolating, one might expect that the death rate should be higher at the earlier stages, such as during gestation. Effects could perhaps extend to gametes. This is, of course, speculative, and requires further study.

It does appear, however, that to a very large extent the mortality rates for the chronic diseases discussed, along with their generation and progression, may be accounted for by considerations of the mechanics of molecular genetics, or of the molecular biology of the gene. The studies have just begun, however, and must be considered very preliminary.

7. Biological Support for Statistical Findings

If the statistical associations we have found should happen to depict causal relationships, then they must reflect the etiology of the diseases involved, at least in part. This report does not present the involved biomedical hypotheses to any great extent, the support for which is still being developed. These are presented in reports submitted to scientific journals or are being developed in manuscripts yet in preparation (4, 29). The present studies have shown significant associations between air pollutants and cancer, heart disease, stroke and congenital malformations. One widely held theory of the cause of cancer attributes it to changes in the normal base sequence of the DNA to yield the initial cancer cell and its progeny. Such changes are known, of course, as mutations. Mutations occur spontaneously at relatively low frequencies. Certain agents, among them radiation and certain chemicals, cause an increase in mutation rate. Among these chemicals is nitrous acid, which is formed when NO_2 is dissolved in water. Nitrous acid is one of the most potent mutagenic chemicals known. As a weak acid, its derivatives with weak bases may dissociate fairly readily. SO_2 is also thought to be mutagenic. Cell characteristics are determined at least to a large extent by the base sequence of the DNA present. Modified DNA yields a modified cell unless the modified DNA code concerns a product the particular cell does not form, as, for instance, alpha-hemoglobin in a skin cell. This is true of all cells, not just gametes. Similarly, DNA changes, either somatic or germinal, are a major cause of congenital malformations.

Metals have been found associated with DNA and are thought to be an integral part of the molecule and/or necessary for its synthesis and replication. If metals are vitally associated with DNA, then proper DNA structure and function obviously requires the correct metal in the correct place at the correct time. Neither causuality nor the basic laws of physics and chemistry are suspended in biological systems. Their applications, however, are highly complex.

Chronic diseases have not yielded their etiology to a classical approach. No specific external chemical or physical agents have been found consistently present for many non-infectious chronic diseases whose frequency of occurrence is associated with increasing age, and which function somewhat analogously with Koch's classical postulates regarding infectious agents. This is to be expected if the disease has a chemical cause. The occurrence of a chemical reaction is dependent not only on the presence of and concentration of the appropriate molecules, but it also involves an energy function, and energy functions are probabalistic. Accordingly, the occurrence of a non-acute, chemically-caused disease also would be expected to be probabalistic.

A set of postulates, corresponding to Koch's classical postulates relating to the causative agent for infectious diseases, has been suggested by former Assistant Surgeon General Robert J. Anderson (28) to apply to chronic, non-infectious diseases. The establishment of causal agents through the application of the postulates suggested by Anderson, or by modifications of these, are under investigation, but studies in this area have not yet led to establishment of causal agents for the chronic diseases and their mechanisms. These considerations are to be dealt with at length in later publications.

8. Major Urban Sources of SO_2 and NO_2, and some Tentative Dose-Response Curves

Nitrogen dioxide arises from automotive emissions, and also from the combustion of coal, fuel oil, and gas, from chemical manufacturing, and from other miscellaneous sources. It occurs at higher levels where high temperature combustion is involved and where there is a sufficiently high proportion of air or other oxidant. Gas generally yields less NO_2 per BTU on combustion than fuel oil or coal.

Sulfur dioxide is an important emission of electric power plants burning coal or oil containing appreciable sulfur. Gas combustion generally yields little SO_2. High sulfur gas would, of course, introduce problems in residential cooking.

Two graphs are included, Figures 1 and 2, which indicate what the predicted annual mortality rates might be for gastrointestinal cancer with varying concentrations of NO_2, SO_2 and copper. In one case, Figure 1, copper and SO_2 concentrations are held constant, SO_2 is considered at three levels, and NO_2 is varied. In Figure 2, NO_2 and copper are held constant and SO_2 is varied. The shapes of the curves reflect the ln c(pollutant) hypothesis. It should not be presumed that better transformations of data could not be found.

The implication of the curves in Figures 1 and 2 is that NO_2 and SO_2 should be eliminated from the atmosphere, not merely held below some level which does not irritate the eyes and throat. Total elimination is evidently not practical, but great efforts should be made to hold them at a minimum.

If the graphs are anywhere near representative of reality, strenuous efforts at attempting to decide whether upper limits for SO_2 and NO_2 may be set at perhaps 60, 70, 80, 90, or 100 $\mu g/m^3$ would appear to be unproductive. It should be noted that atmospheric SO_2 concentration in a number of California communities is quite low, often below 20 or 25 $\mu g/m^3$. NO_2 levels in California are, however, often fairly high.

9. Relationships Between Automotive Emissions and Chronic Diseases

Thus far, of the air pollutant chemicals studied, two are components of the exhaust from the gasoline-driven internal combustion engine. These are nitrogen dioxide and lead.

Of the chronic diseases discussed in this report, nitrogen dioxide concentration is a positively correlated, significant predictor (see regression equations) for:

(a) Gastrointestinal cancer
(b) Total cancer
(c) Cancer of the genital system
(d) Vascular lesions affecting the central nervous system (stroke)
(e) Arteriosclerotic heart disease, and
(f) Diseases of the heart (broad category).

Nitrogen dioxide concentration in the air is negatively correlated with mortality rate for congenital defects.

Lead concentration in the air is positively correlated with the mortality rate for congenital malformations. This should be interpreted with care.

All of these findings were obtained from multivariate analysis of large sets of man-environment data.

Other automotive emissions or derivatives yet to be examined include NO, CO, hydrocarbons, and oxidants or peroxides, among others. Data are partly set up for studies of these chemicals.

10. The Philadelphia Regional Air Pollution Problem

Clearly, there is no point in obtaining environmental chemical data unless there is a use for the data. There are known to be connections between air pollutants and agricultural damage, corrosion, and other economic problems. The Donora event and other similar pollution crises are also well known. General deleterious effects of air pollution are widely known, but these are largely acute effects, e.g., watering eyes, irritated throat and upper respiratory system.

Our recent studies have, however, demonstrated both qualitatively what pollutants are associated with certain chronic diseases, and what the quantitative relationships are in terms of multiple regression equations.

Applications of quantitative findings, to be particularly meaningful, must have not only general but specific utility, though a general solution to general problems may be considered as highly desirable. Our evidence relates to a general solution which, of course, has specific applications. In particular, let us consider the Philadelphia regional problem.

Philadelphia pollutant data which involve those pollutants significantly associated with mortality rates for cancer, heart disease and stroke are available.

For the initial cancer study (4) the significant pollutants were found to be

SO_2, NO_2, copper and particulate $SO_4^=$, with copper being negatively correlated. For convenient comparison, data for Philadelphia and Wilmington are compared with New York City; a low pollution city, Charlotte, N. C.; and a large city with low SO_2, Los Angeles. These data are shown in Table 1.

As is evident from Table 1, below, the data for Philadelphia and Wilmington are similar, but the latter has about half the SO_2 concentration. New York has generally quite high atmospheric concentrations of the three presumably deleterious pollutants, SO_2, NO_2 and $SO_4^=$, while copper is not unusual. The low SO2 level in Los Angeles stands out, and the low general pollution levels of Charlotte are notable. The low levels for Charlotte and the low SO_2 level in Los Angeles (and in other California cities) indicates what is possible. It is recognized that fuel consumption patterns differ from region to region. The SO_2 and NO_2 data may be examined in connection with the graphics of Figures 1 and 2.

Table 1

Comparison of SO_2, NO_2, Copper and Sulfate Atmospheric Levels for Philadelphia, Wilmington, and several other Cities

	Mean Annual Pollutant Concentration in $\mu g/m^3$			
City	NO_2	SO_2	Cu	$SO_4^=$
Philadelphia, Pa.	107	217	0.080	22.7
Wilmington, Del.	102	90	0.095	19.0
New York, N. Y.	153	408	0.133	29.0
Charlotte, N. C.	33	11	0.055	7.5
Los Angeles, Calif.	206	20	0.158	13.7

Source: Reference 4

The Philadelphia-Wilmington data and their relationship to the multiple regression equations for cancer, heart disease and stroke, indicate that the atmospheric concentrations of NO_2, SO_2 and $SO_4^=$ are excessively high, and very serious efforts should be made to reduce emissions which contribute to these high levels. This conclusion may be made, of course, only to the extent that there may be confidence in the analytical findings. Further research to demonstrate cause and effect relationships must be pursued. Some support has been obtained from biochemistry and physiology. Much more evidence is needed for conclusive proof; however, the risk of failing to take action on the basis of present evidence is considerable. The emission sources are, to a large extent, known.

Regarding other predictors noted in Tables 3 through 7, hardness of water appears to be negatively correlated with certain cardiovascular disease rates. Philadelphia water was reported at 83.5 ppm of $CaCO_3$, and Wilmington at 48 ppm. These are not unusual, though Wilmington water is somewhat soft. One might contemplate the effect of water softeners for drinking water.

Philadelphia is rather high in atmospheric vanadium (0. 24 $\mu g/M^3$), while Wilmington is quite high (0. 557 $\mu g/m^3$; one measurement) compared with data such as 0. 03 $\mu g/m^3$ and less for many other cities.

Compared with other cities, Philadelphia and Wilmington have atmospheric lead levels higher than many of the cities studied, while the chromium level was not unusual in Philadelphia, but appeared somewhat high in Wilmington, compared with other cities.

On the basis of the preceding considerations, governmental regulatory procedures to limit certain environmental chemical exposure of the public seem necessary.

11. Governmental Regulatory Standards for Pollutants in the Philadelphia Region

While national pollutant standards appear to offer possibly the best solution for control in order to overcome such threats as having industry move from an area of rigid regulations to one of loose or non-rigorous control, the problem will be noted briefly in terms of the Philadelphia region.

Referring again to Figures 1 and 2, if these dosage-response curves are even approximately accurate, the obvious first conclusion may be that NO_2 and SO_2 should be eliminated from urban and rural air. Since this does not appear feasible, the next best conclusion would be to drastically reduce the NO_2 and SO_2 levels in the broad Philadelphia region. Current or representative SO_2 and NO_2 levels, see Table 1, are so high as to be in the relatively flat response portions of the curves.

Holding SO_2 constant at 200 $\mu g/m^3$, and copper constant at 0. 08 $\mu g/m^3$, reducing the NO_2 mean concentration from about 107 $\mu g/m^3$ (see Table 1) to 50 $\mu g/m^3$ would reduce the computed gastrointestinal cancer mortality rate from about 65 to 55 per 100, 000 persons. A similar reduction with SO_2 constant at 50 $\mu g/m^3$ would reduce the rate from 54 to 44 deaths per 100, 000 persons. For other similar data, see Table 2, below.

Table 2

Hypothetical Application Showing Computed Changes in Philadelphia Gastrointestinal Cancer Mortality Rates with Changes in Atmospheric SO_2 and NO_2 Concentrations

Atmospheric Conc. in $\mu g/m^3$			GI Cancer Annual Mortality Rate per 100,000 persons
SO_2	NO_2	Cu	
200	107	0. 08	65
200	50	0. 08	55
200	20	0. 08	42.5
200	10	0. 08	33
50	107	0. 08	54
50	50	0. 08	44
50	20	0. 08	31.5
50	10	0. 08	22

Source: Figure 1

In Table 2, the 10 $\mu g/m^3$ data for NO_2 are extrapolated, since input data are not that low.

To what extent the SO_2 and NO_2 levels may be reduced is to a large extent a question of economics. This, then, becomes a matter of determining how costly illness and death is. It has been estimated (24), however, that cancer, heart disease and stroke have an annual cost in the United States of $30 billion or over.

It cannot be concluded, however, without additional evidence, that reducing various pollutant levels toward zero concentration will eliminate cancer, heart disease, stroke and other types of chronic disease. If the molecular genetic theory is correct, certain aging or senescence processes will occur in the absence of radiomimetic or mutagenic chemicals. It may be well to consider aging, and its covariates, the development of various chronic diseases, to be in part chronological and based on molecular genetic changes which occur in the absence of radiomimetic chemicals, and in part radiomimetic - mutagenic, based on effects of external variables, such as environmental chemicals, radiation, virus history, and perhaps including effects of food preservatives, insecticides, cosmetics and drugs. Regarding drugs, one must not forget the thalidomide tragedy. There are reports concerning the relationship between the occurrence of lupus erythematosis and the extended use of a variety of approved pharmaceuticals (20). The effects of socioeconomic variables such as crowding and malnutrition should also be included in this very complex problem.

Subsequent studies may, and should, show that the physiological aging rate increases with the concentration and period of exposure to radiomimetic chemicals, such as NO_2 and SO_2. If this is proven, then the chemicals would be involved in bringing about aging at a faster rate and reducing life expectancy, in reducing the economically productive or earning period of populations, and in replacing some of this earning period with a costly period of disease control and treatment while the patients are unable to contribute to the gross national product. This is, of course, aside from considerations of personal suffering and hardship. So the loss is magnified: the conversion is not from production to non-production, but from production to loss. This should be examined by economists after environmental chemicals vs. aging studies are made. The force of evidence for cleaning up the environment, then, might be overwhelming.

TABLE 3.
Single and Multiple Regression Equations for the Prediction of the Mortality Rate for Lung, Gastrointestinal and Total Cancer (Study II)

Eq No	Regression Coefficients for Predictors					Multiple Coefficients of		Error Variance	Standard Error of Estimate	d.f.	F-Statistic for Test of Significance of R	Tabular F	α
	Constant	ln $c(SO_4^=)$	ln c(Cu)	ln $c(SO_2)$	ln $c(NO_2)$	Det'n. R^2	Corr. R						
LUNG CANCER													
1	13.07	5.735				.343	.586	12.51	3.54	1,36	18.8	7.39	0.01
2	4.528	6.459	-2.806			.449	.670	10.49	3.24	2,35	14.3	5.27	0.01
GASTROINTESTINAL CANCER													
3	14.73			9.099		.398	.631	97.6	9.88	1,36	23.8	7.39	0.01
4	-36.99			7.867	12.57	.496	.704	81.8	9.05	2,35	17.2	5.27	0.01
5	-61.54		-6.925	8.809	13.47	.571	.756	69.6	8.34	3,34	15.1	4.42	0.01
TOTAL CANCER													
6	90.11			16.81		.297	.545	509.9	22.6	1,36	15.23	7.39	0.01
7	-30.84			13.93	29.39	.417	.646	423.0	20.6	2,35	12.53	5.27	0.01
8	-95.14		-18.74	16.40	31.74	.538	.734	335.1	18.3	3,34	13.21	4.42	0.01

TABLE 4.
Single and Multiple Regression Equations for the Prediction of the Mortality Rate for Lung Cancer (Study III)

Eq No	Regression Coefficient for Predictors							Multiple Coefficients of		Error Variance	Standard Error of Estimate	d.f.	F-Statistic for Test of Significance of R	Tabular F	α
	Constant	ln $c(SO_4^=)$	ln c(Ti)	ln c(Cr)	ln c(Cu)	ln c(HW)	Median Age	Det'n. R^2	Corr. R						
1	13.07	5.736						.343	.59	12.51	3.54	1,36	18.81	7.39	0.01
2	3.737	6.394	-2.701					.454	.67	10.40	3.23	2,35	14.56	5.27	0.01
3	13.85	4.742	-4.165	2.844				.542	.736	8.73	2.95	3,34	13.41	4.42	0.01
4	9.578	5.173	-3.495	2.701	-1.912			.583	.763	7.95	2.82	4,33	11.52	3.95	0.01
5	1.657	5.627	-3.604	2.877	-2.652	1.266		.630	.794	7.04	2.65	5,32	10.91	3.66	0.01
6*	1.652	5.628	-3.603	2.877	-2.653	1.266		.630	.794	7.04	2.65	5,32	10.91	3.66	0.01
7*	-16.646	3.564	-2.617	2.234	-1.987	1.641	0.8076	.750	.87	4.77	2.18	6,31	15.49	3.45	0.01

*These equations were obtained from a modified computer program using the IBM System/360/65. The previous equations were obtained by analysis on the IBM 1620 Model II Computer.

TABLE 5.

Multiple Regression Equations for the Prediction of the Mortality Rates for Gastrointestinal, Upper Respiratory and Genital Cancer Showing Influence of Age Variable (Study III).

Eq No	Regression Coefficients for Predictors							Multiple Coefficients of		Error Variance	Standard Error of Estimate	d.f.	F-Statistic for Test of Significance of R	Tabular F	α
	Constant	ln $c(NO_2)$	ln $c(SO_2)$	ln c(Cu)	ln c(Ti)	ln $c(SO_4^=)$	Median Age	Det'n. R^2	Corr. R						
	GASTROINTESTINAL CANCER, M_2														
1	-61.529	13.463	8.809	-6.924				.571	.755	69.6	8.34	3,34	15.08	4.42	0.01
2	-94.855	5.751	2.701	-0.5467			3.656	.785	.89	34.8	5.90	4,33	30.18	3.95	0.01
	CANCER OF THE UPPER RESPIRATORY SYSTEM, M_4														
3	-1.171				-1.024	0.8611		.427	.653	0.519	0.720	2,35	13.02	5.27	0.01
4	0.1564				-0.8425	0.3884	0.1564	.523	.72	0.431	0.657	3,34	12.44	4.42	0.01
	CANCER OF THE GENITAL SYSTEM, M_5														
5	-2.541	3.222	1.048	-2.193				.264	.51	7.23	2.69	3,34	4.07	3.53	0.025
6	-9.565	1.591	-0.2307	-0.8672			0.7680	.407	.64	5.82	2.41	4,33	5.68	3.95	0.01

TABLE 6.

Multiple Regression Equations for the Prediction of the Mortality Rates for Heart Disease and Stroke and Showing the Influence of the Age Variable.

	Regression Coefficients for Predictors									Multiple Coefficients of		Error Variance	Standard Error of Estimate	d.f.	F-Statistic for Test of Significance of R	Tabular F	α
Eq No	Constant	ln c(NO_2)	ln c(Cu)	ln c(V)	ln c(SO_2)	ln c(HW)	ln c(Cd)	ln c($SO_4^=$)	Median Age	Det'n. R^2	Corr. R						
VASCULAR LESIONS OF THE CENTRAL NERVOUS SYSTEM (STROKE)																	
1	-78.326	26.703	-16.664	-4.089						.268	.518	286.8	16.94	3,34	4.15	3.53	0.025
2	-141.93	21.143	-13.967	-5.630					2.9880	.346	.59	256.4	16.01	4,33	4.36	3.95	0.01
ARTERIOSCLEROTIC HEART DISEASE																	
3	-211.33	63.062			42.003	-20.305	-24.893			.448	.67	2511	50.11	4,33	6.70	3.95	0.01
4	-399.02	3.1757			3.4301	-7.9796	-6.0729		22.224	.726	.86	1249	35.33	5,32	16.93	3.66	0.01
DISEASES OF THE HEART																	
5	-232.29	67.927			39.508	-29.286	-28.131	46.736		.590	.77	2695	51.9	5,32	9.22	3.66	0.01
6	-453.61	7.853			0.2887	-15.611	-6.964	30.000	25.094	.840	.92	1053	32.46	6,31	27.08	3.45	0.01

TABLE 7.
Single and Multiple Regression Equations for the Prediction of the Mortality Rate for Congenital Malformations and Showing the Influence of the Age Variable.

Eq No	Regression Coefficients for Predictors						Multiple Coefficients of		Error Variance	Standard Error of Estimate	d.f.	F-Statistic for Test of Significance of R	Tabular F	α
	Constant	ln $c(NO_2)$	ln c(HW)	ln c(Pb)	ln c(Zn)	Median Age	Det'n. R^2	Corr. R						
1	24.955	-2.816					.305	.553	2.015	1.42	1,36	15.83	7.39	0.01
2	21.521	-2.616	0.6001				.382	.618	1.793	1.34	2,35	10.81	5.27	0.01
3	24.206	-3.172	0.6129	0.9397			.432	.657	1.647	1.31	3,34	8.63	4.42	0.01
4	22.370	-2.877	0.6675	1.3455	-0.5937		.494	.702	1.47	1.21	4,33	8.05	3.95	0.01
5	26.680	-2.418	0.5062	1.3708	-0.5860	-0.1917	.543	.74	1.327	1.15	5,32	7.59	3.66	0.01

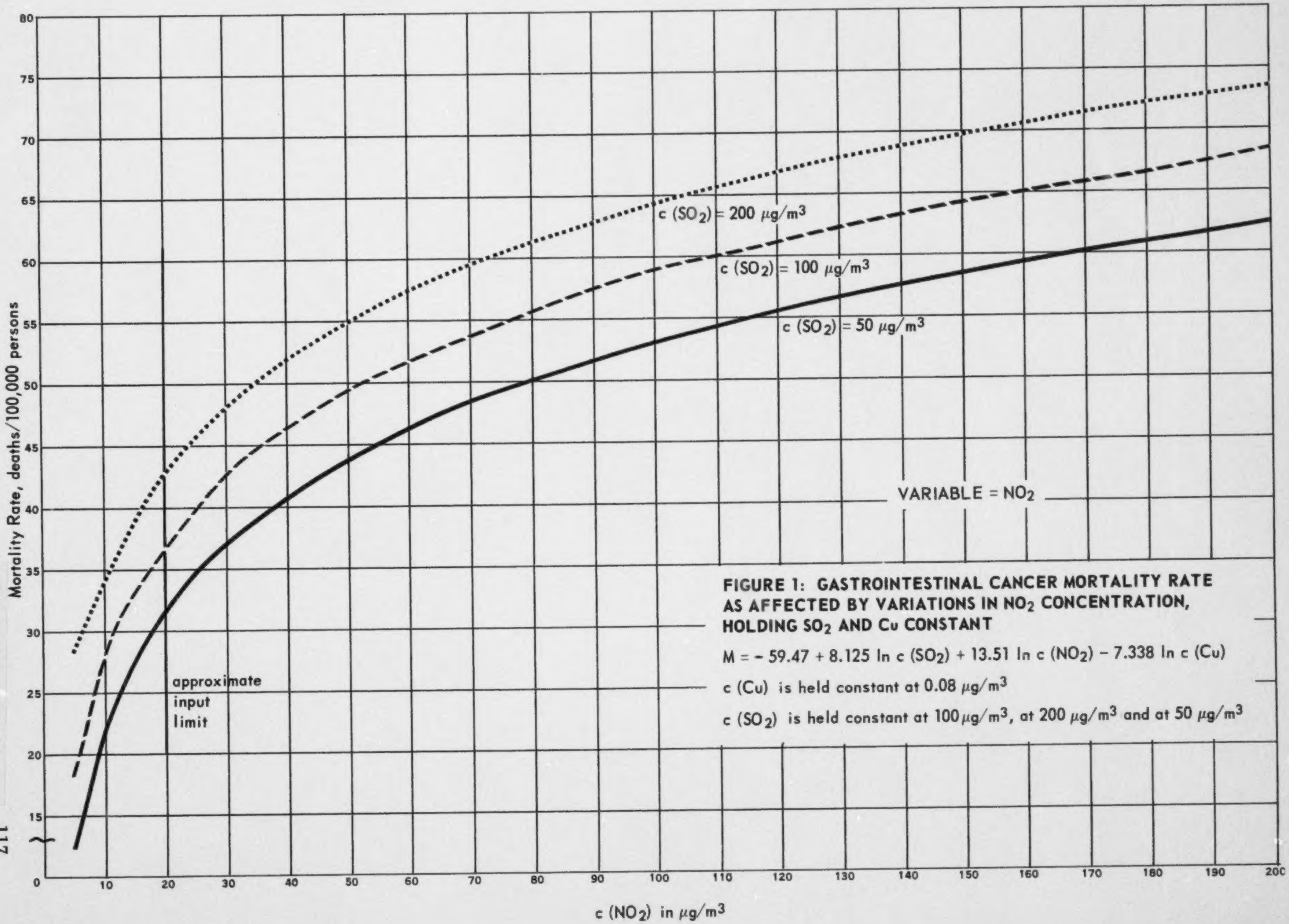

FIGURE 1: GASTROINTESTINAL CANCER MORTALITY RATE AS AFFECTED BY VARIATIONS IN NO_2 CONCENTRATION, HOLDING SO_2 AND Cu CONSTANT

$M = -59.47 + 8.125 \ln c\ (SO_2) + 13.51 \ln c\ (NO_2) - 7.338 \ln c\ (Cu)$

$c\ (Cu)$ is held constant at $0.08\ \mu g/m^3$

$c\ (SO_2)$ is held constant at $100\ \mu g/m^3$, at $200\ \mu g/m^3$ and at $50\ \mu g/m^3$

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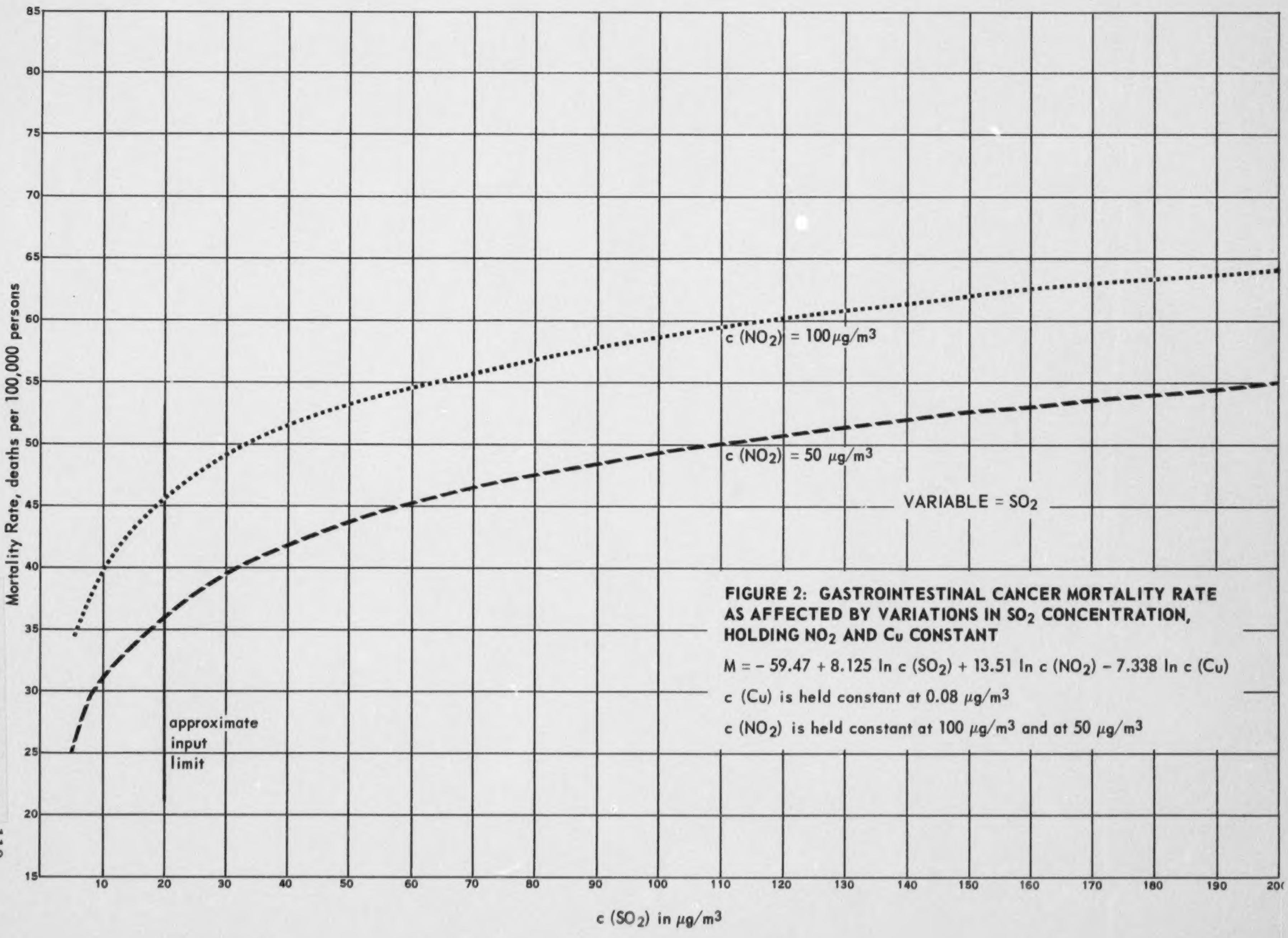

FIGURE 2: GASTROINTESTINAL CANCER MORTALITY RATE AS AFFECTED BY VARIATIONS IN SO_2 CONCENTRATION, HOLDING NO_2 AND Cu CONSTANT

$M = -59.47 + 8.125 \ln c(SO_2) + 13.51 \ln c(NO_2) - 7.338 \ln c(Cu)$

c (Cu) is held constant at 0.08 μg/m³

c (NO_2) is held constant at 100 μg/m³ and at 50 μg/m³

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SECTION IV

ECONOMIC ASPECTS OF AIR POLLUTION CONTROL*

Summary of Study Findings

Clean air is a scarce resource. It is demonstrated in this study that the same conditions which are necessary for the efficient allocation of scarce resources in the private sector of the economy are also required for the efficient allocation of scarce resources in the public sector. In general, to maximize the net social benefit, the level of activity must be adjusted so that the marginal benefits from the activity equal the marginal costs of the activity.

Two basic strategies for air pollution control are presented: (1) equiproportional abatement, and (2) selective abatement. These strategies reflect basic economic considerations. Equiproportional abatement is the simplest method; it assumes that all pollution sources will reduce their emissions in the same proportion as the desired reduction in air pollution concentrations. The objective of selective abatement is to find the minimum cost combination of abatement while still satisfying the air quality standard. The theory underlying selective abatement is that (1) the cost of a unit reduction of emissions is not necessarily the same for all pollution sources; and (2) the effect of air pollution upon a particular receptor (person, agriculture crop, building, etc.) of a unit reduction of emissions is not necessarily the same for all pollution sources. Thus, for each source it is necessary to know the cost of the abatement, the amount of emissions, and the relationship between that source and any receptor.

For economically efficient air pollution control, the degree of selective abatement is set at the level where the marginal cost of abatement to each source is equal to the sum of resulting marginal benefits from abatement at each receptor. For equiproportional abatement, the optimal level of abatement is reached when the sum of the marginal costs of equiproportional abatement is equal to the sum of the resulting marginal benefits. Emission standards exemplify equiproportional abatement. In contrasting these alternative methods of air pollution abatement, it is shown that equiproportional abatement is generally a less efficient method of control. In circumstances where there are many small sources of pollution, the cost of administering selective abatement may outweigh the additional efficiency it provides.

The chief problem in the application of the marginal cost -- marginal benefit model is the incomplete knowledge of the effects of air pollution. However, a method of attacking the problem can be demonstrated for an area where sufficient emissions and cost data are available.

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* Analysis of the economic impact of air pollution control was performed by Drs. Azriel Teller and J. R. Norsworthy and a full report prepared. This section presents only a summary of the full report, the synthesis and conclusion section, and a section on cost distribution alternatives. Copies of the full report can be made available through the Government Studies Center.

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There are alternative methods of financing an air pollution abatement program so as to use economic incentives to accomplish pollution control objectives. A number of alternative theoretical approaches which can be used to estimate the cost of satisfying different air quality standards are presented. The extent to which each model is used is determined by available data describing the environment, the desire to satisfy the standard, the desire to achieve accuracy in the estimates, and the desire to minimize the cost of air pollution control to society.

With respect to alternative techniques for financing air pollution control, economic theory cannot answer the ethical issue of liability, but can suggest the comparative effectiveness of different financing alternatives. It is suggested that strong economic incentives in the form of effluent fees and possibly abatement subsidies be employed in the long term to combine both financing and enforcement of an air pollution control program. In order to obtain the greatest benefit for the least cost, it is suggested that for long range practice air pollution damage and the reduction thereof serve as the basis for effluent fees and abatement subsidies respectively.

For the most effective least-cost management of a severe problem such as characterizes the Penjerdel Region, a short term selective abatement program is suggested. Such a program could be financed by effluent fees levied on pollution sources proportionate to each source's contribution to total emissions in the region.

There are problems that arise in decision making for implementation of an air pollution control program, and there are minimum data requirements and uses for an economically efficient approach to air resource management. Data requirements are described for a system of estimating the concentrations of various damaging pollutants throughout the Penjerdel Region. Such a system provides the best estimates of contributions by each source to total air pollution damage, and of the effects of policy on various economic activities in the region. Long range air resource management planning requires this kind of information to be both effective in reducing air pollution and in minimizing the cost of control.

A synthesis of prior theoretical discussion and consequent conclusions for the Penjerdel Region follows this summary. Dr. Richard J. Hickey's preliminary results, as described in the health impact section of this Report, suggest quite substantial health damage from atmospheric pollution, and hence substantial health benefits to be captured from immediate steps to control air pollution. Of alternative strategies now facing the region, a selective abatement program to be financed as suggested above, coupled with a strong effort to expand knowledge of regional air pollution sources and effects, is recommended, based on economic considerations.

Certain interregional economic problems are also discussed as are some of the implications of regional industrial and population growth for future air resource management. A program using an input-output model of the regional economy is suggested for improving knowledge of the economic impact of air pollution and its control. The economic reasoning for immediate implementation of an air pollution control program is summarized.

A. Synthesis and Conclusions of the Economic Analysis

1. Economics and the Air Pollution Problem in the Penjerdel Region

Economic analysis demonstrates that a region attains the best solution to its air pollution problem when the marginal social cost of air pollution control is just equal to the consequent marginal social benefit. Therefore, in order to determine the best level of control within fairly narrow limits, it is first necessary to have estimates of known reliability of both the costs and benefits of air pollution control in the region.

The cost and benefit information presently available for the Penjerdel Region does not permit estimation of an ideal level of control. However, Dr. Richard J. Hickey's estimates of the health effects of air pollution strongly suggest that the level of air pollution for which the marginal costs and marginal benefits of control will be equal is a very low level indeed, requiring a high degree of air pollution abatement. Estimates of the cost of controlling various pollutants associated with various levels of abatement are simply not available at this time. Dr. Azriel Teller's work in comparing two abatement strategies,[1] uniform and selective abatement, clearly demonstrates that selective abatement is considerably less costly than uniform or equiproportional abatement for low and intermediate levels of air pollution control. While it is essential that further research be undertaken to elucidate these cost and benefit relations, the weight of the presently available evidence strongly suggests that air pollution abatement must begin in the Penjerdel Region as soon as practicable.

Alternative strategies presently facing the proposed air pollution control authority for the Penjerdel Region are as follows: (1) Do nothing; (2) Initiate research programs and await results before moving toward abatement; (3) Initiate a uniform abatement program (with or without ultimate air quality standards being specified); (4) Initiate a selective abatement program (with or without ultimate air quality standards being specified).

Clearly alternative one has nothing to recommend it. Alternative two will have the same effect as one on the welfare of the region's population for whatever length of time is necessary to determine, within sufficiently narrow limits, the ideal level of air pollution control. Because the health effects estimates by Dr. Hickey indicate a high annual health cost of continued pollution at the present level, and because any abatement program will require several years for full implementation, the only responsible strategies for regional policymakers are alternatives three and four. The "research gap" alluded to above suggests that there is little basis for a final specification now of ultimate air quality standards, although the direction for social policy is eminently clear. A research program combined with an abatement program is necessary. The scope of such a research program is suggested below. It remains only to decide between alternatives three and four with interim air quality standards to be specified, or with specification deferred until further research permits a more precise determination.

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[1] Azriel Teller, Air Pollution Abatement: An Economic Study into the Cost of Control, unpublished Ph. D. Dissertation, John Hopkins University, 1967

Selective abatement has several obvious advantages over uniform abatement as an air pollution control policy, especially in the early stages of a control program. First, abatement to achieve any air quality standard requiring less than 100% reduction in emissions is more cheaply accomplished through selective abatement. Second, major sources of pollutants (other than NO_2) generally contribute a large proportion of total discharge in a region. Identification of these major sources, and control through direct stack sampling, is far simpler administratively, and more effective in improving air quality, than would be the case with a uniform abatement program. Third, a selective abatement program dovetails administratively with a crisis management program (discussed below), which is a sensible initial accompaniment to an air pollution control program. Finally, selective abatement permits discrimination between plants and industries for which control is technologically feasible and economical, and those for which it is not. Selective abatement also simplifies administration of the interim use of subsidies and/or tax credits to encourage reduction of pollutant emissions where cost is prohibitively high or would cause the plant to relocate or otherwise suffer.

2. The Region

Definition of a region for purposes of air pollution control runs the risk of being out-dated in a relatively short period of time -- say, ten to twenty years. Unlike water pollution control, air pollution control has no ready physical reference analogous to a watershed. As pointed out by Dr. John R. Mather, there is no Penjerdel "airshed" or "air basin." Air pollution is the consequence of economic and social activity. To the extent that a sufficient intensity of such activity spreads in the future to and beyond the boundaries of the eleven-county area, the region as currently defined will no longer adequately span the sources of pollution contributing to its problem.

With respect to regional boundaries, three cases of air pollution impact may be distinguished:

(a) pollution from regional sources which affects regional resources;

(b) pollution from regional sources which affects resources outside the region;

(c) pollution from sources outside the region which affects regional resources.

The regional air pollution control authority is typically both empowered by enabling legislation and motivated by its constituency to deal with case (a); it is motivated but not generally empowered to deal with case (c). Case (b) and (c) may be dealt with effectively between adjacent authorities, provided neither clearly has the upper hand -- i. e., one region exports far more pollution to its neighbor than it imports.

Enabling legislation for air pollution control in Colorado empowers a local authority to control any source which contributes significantly to the level of pollution within the boundaries of the local pollution authority's control area; this seems to be an ideal solution to the problem posed by case (c). This provision eliminates part of the difficulties which may arise from the "announcement effect" of control legislation: that heavy pollutors will prefer to locate just beyond the boundaries of the region. Under such a provision, at least the "upwind" boundary would be protected. Inclusion of such a provision is strongly recommended. Similarly, a provision requiring the authority to police regional pollution sources to prevent excessive contribution to pollution concentrations beyond the regional boundaries would deal with case (b).

3. The Regional Transport Network

While super-highway and expressway traffic emissions are not as severe a problem in the aggregate within the Penjerdel Region as, say, in Los Angeles or Chicago, the automobile seems to be a major source of NO_2, and is the major source of CO and certain hydrocarbons. It appears unlikely that a single region such as the Penjerdel eleven-county area acting alone, will be able to influence national automobile emission standards. Nevertheless, preliminary estimates of the health effects of environmental pollutants rather strongly suggest control of NO_2. Perhaps the effectiveness of the Penjerdel Region in influencing national automotive emission standards can be maximized through cooperative lobbying with similar regions having severe problems of auto emissions. The three states of which the region is constituted should consider adopting restrictive emission standards for new automobiles, such as those of California.

Short-term crisis management (discussed below) for the near future seems necessary to avoid severe episodes from high NO_2 concentrations. The prospects are remote that the Penjerdel Region will observe a substantial replacement of automotive travel by rapid transit travel, or that the problem will otherwise meet solution through tunnelling or widespread use of electric automobiles.

If the health effects of automotive emissions are revealed to be particularly severe by future research, it may become advisable to require installation of control devices, when they become technically and commercially feasible, on all automobiles. The state inspection systems and/or city--county licensing activities provide a ready means of inspection and control.

4. Industrial Pollution and Growth in the Region

Generally speaking (and the geographic detail of emissions data for the Penjerdel Region admits of nothing more specific), the greatest geographic source of much gaseous and particulate pollution is along the Delaware River. This results in a particulate concentration gradient which falls away from the river to the east and west. It is reasonable to expect that other pollutants such as SO_2 will be characterized by a similar pattern.

Heavy industry -- steel, oil refining, etc. -- has been growing in the recent past at a rate about the same as that of population growth, and consequently slower than the aggregate of economic activity, or GNP. If this trend persists, and if this trend be presumed to characterize the Penjerdel Region, the pollution in the region may be expected to increase roughly in proportion to the population of the region. Because per capita income in the region is increasing and may quite reasonably be expected to do so in the future, the resources available to deal with the pollution problem -- the tax base -- will be growing faster than the resources required to deal with it. This conclusion is strengthened by the likelihood that cheaper control techniques will be developed within the next five to ten years.

The geographic concentration of the pollution problem in the Penjerdel Region suggests pollution control policies which combine zoning with selective abatement in early phases of air resource management. Control by zones permits highest priority for controlling pollution where the problem is most intense; selective, as opposed to uniform, abatement permits least-cost attainment of air quality standards. It is therefore suggested that selective abatement be initially undertaken in the heavily industrialized river-front area where concentration of pollutants is highest and where, therefore, decrements in concentration will yield the greatest social benefit.

Because the selective controls may discriminate among otherwise similar plants and/or firms, it may be desired to soften the impact of such control by granting state and/or local tax credit, or subsidies, for the purchase of control equipment. It is most important in the administration of such incentives, however, that two economic factors be recognized. First, such incentives should be used only when the annual cost of control per unit of the plant's annual output is affected in a substantial way, and when the plant would thereby be disadvantaged in its market position.[2] Second, the tax credits or subsidies should be granted according to the reduction in emissions, and not according to the cost of the control devices or process changes. The objective of the incentives should be to subsidize benefits from reduced emissions rather than to subsidize the manufacturers of control equipment. Incentives would encourage the plant's operators to look for the most effective means of control, whether it be equipment or fuel substitution or process modification. If on the other hand, the cost of a control technique is to be largely defrayed by the public in any case, there is far less incentive to innovate or to search for the most efficient control methods. By maintaining up-to-date information on control devices and methods for various kinds of polluting industry, and by monitoring the effectiveness of those adopted and in use, the regional control authority can simplify the task of the selectively controlled emission sources. Further, new plant construction or plant expansion planning can be facilitated.

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[2] A summary report of the Federal Working Committee on Economic Incentives, entitled Cost Sharing with Industry?, stated:

"The additional annual cost for manufacturing firms and electric plants (excluding thermal pollution abatement) to achieve the hypothetical quality standards considered in this report for both air and water pollution is estimated to be about two-thirds of $1 billion or less than 1/3% of value-added for manufacturing and the electric power industries." (p. 3)

For air pollution, the standard is "a 60% to 75% reduction of human exposure to sulfur oxides and particulate pollutants in all standard Metropolitan Statistical Areas." (p. 3)

"The studies above clearly indicate the annual expenditures by manufacturers for air and water pollution abatement are likely to be relatively small." (p. 29)

"Moreover, Federal assistance to industry is already sizeable. . . Therefore the need and desirability of additional assistance for industry should be judged on the basis of hardship or burden on particular industries, firms or plants (or hardship on particular communities) caused by abatement actions rather than on the burden to industry as a whole." (p. 1)

Cost Sharing with Industry?, Summary Report of the Working Committee on Economic Incentives (Revised), under the direction of the Federal Coordinating Committee on the Economic Impact of Pollution Abatement, November 20, 1967.

One method of air pollution abatement that requires special mention is fuel substitution. By substituting low sulfur for high sulfur fuel oil, concentrations of SO_2 in a metropolitan area can be substantially reduced. This substitution, however, is likely to impose rather severe hardships on the soft coal industry in western Pennsylvania and elsewhere. These hardships may be expected to prevail until the sulfur can be removed before combustion, or the sulfur dioxide can be removed after combustion at a cost per ton which is no greater than the price difference between soft coal and fuel with lower sulfur content. Clearly in this case there is a trade-off between health in the Penjerdel Region (assuming the validity of Dr. Hickey's thesis, though not necessarily the precision of his estimates) and jobs in an already declining industry, in Western Pennsylvania. Whatever decision is made as to how the burden shall be borne, the burden is not a trivial one.

5. Regional Air Pollution Alerts -- Crisis Management

While the Penjerdel Region is moving toward an adequate air pollution abatement program, it may be worthwhile to institute an air pollution alert system. Such a system is currently being implemented for the City of Chicago, and operates approximately as follows.[3] When the weather forecast indicates a strong likelihood of conditions conducive to a "pollution crisis" -- low inversion level, low wind velocity, high atmospheric stability -- graduated control measures are applied to selected major pollution sources (e. g. , reduced level of operation, plant shut down, change over from coal to stand-by gas combustion, restricted motor vehicle travel, etc.).

Such a warning system has obvious advantages in averting severe air pollution crisis at a relatively low cost. Almost the same resources are required for establishing and administering the program as for the early stages of a selective abatement program, and there is no requirement for the effectiveness of the latter that meteorological forecasts be accurate. Furthermore, the health effects of environmental pollution seem to result from chronic exposure, although the irritation from episodes may be more noticeable. Consequently, the public may be misled into thinking that the limited program is sufficient. In any event, the crisis alert system should be considered as a transitional supplement to a long term abatement program, rather than as a substitute.

6. Basis for an Initial Study of the Impact of Alternative Air Pollution Abatement Policies on the Penjerdel Region.[4]

In order ideally to evaluate the impact of air pollution controls on the Penjerdel Region, we should be able to answer the following questions: (a) What will be the short and long run effects of different types and levels of controls on the regional and national allocation of resources?, and (b) Are these effects desirable or undesirable for the region and the nation as far as a socially optimal allocation of resources is concerned?

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[3] A discussion of the New York-New Jersey alert system can be found in F. A. Glenn, Jr. "Regional Air Pollution Warning System", Journal of the Air Pollution Control Association (January 1966/pp. 22-24).

[4] The basis for this section was substantially contributed by Dr. Reuven Hendler of Temple University.

There are two "kinds" of social costs and benefits of air pollution controls. We can refer to them as the direct and indirect effects.

a. Social Benefits:

(1) Direct benefits of air pollution controls will include the effects on health, property, and agriculture.

(2) Indirect social benefits will exist if, without controls, the allocation is not at a socially optimal level and as a result of the controls private enterprise will reallocate and change its price-output levels in a more socially "efficient" manner.

b. Social Costs:

(1) Direct costs of installing and maintaining air pollution controls.

(2) Indirect social costs by inducing a socially "undesirable" reallocation of resources in the region and the nation.[5]

While estimation of the direct effects is relatively easy, the measurement of the indirect effects will require an ambitious study both on the theoretical and practical levels. It will require not only the ability to estimate the regional and national impact of air pollution controls but also the evaluation of that impact, i.e., the determination of a socially optimal allocation and the comparison of the actual allocation, with and without air pollution controls with that social optimum.

At the present, it seems desirable to undertake a pilot study which will concentrate on the direct effects of air pollution controls and their probable regional impact, without becoming involved with the problem of optimal social allocation. The impact study will require the following steps:

(1) The determination of the different industries and individuals that will be directly affected by the air pollution controls under consideration. This will involve (a) an explicit mapping of air pollution control zones (APCZ), and (b) estimates of the impact of such controls on the costs and profits of each firm. In order to obtain that information, it is necessary to know the direct cost of air pollution control techniques and the cost and revenue structure of the major industries and firms implementing the techniques.

(2) An estimate of the impact of short and long run increases in costs of production, due to air pollution controls, on these industries and firms. The consequent impact through possible loss of market position on employment and spending in the region must also be calculated.

In the short-run, the effects will include adjustments in the distribution of output among specific plants and firms determined by their location in different APCZ's and the possible effect on the prices of the different products. The possible change in the price ratios of the different products may have a secondary effect on the output of the industries affected, a substitution effect if the price ratios of related industries are affected.

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[5] This may occur when there are other externalities present and/or as a result of market imperfections.

The long-run effects will include the possible relocation of the different plants to a different APCZ either within or outside of the region. A decision to relocate out of the region may also have an immediate effect on the demand for labor by the construction industry in different regions. Secondary regional adjustments will take place through the impact on the industries which are related to the construction industry.

Estimating the impact of changes in location, output, and prices on regional and national employment spending and income is essential. Input-output techniques are most conveniently used, including economic-base studies and regional and inter-regional multipliers. While the state of existing knowledge is not sufficient to provide all the information which theory ideally requires, it is sufficient for many purposes to estimate an upper limit to possible impacts of air pollution controls on regional employment and income. Such a study will require testing the sensitivity of the results to the different variables. The upper limit of the costs of regional impact of air pollution control may be very useful since it may be found, for example, that the estimated lower limits of social benefits of air pollution controls exceed the upper limit of the costs, which will provide a sufficient argument for such controls.

Further, an input-output model of the Penjerdel region provides a system for ready feedback of the benefits of air pollution control into the economic system in terms of, for example, reduced maintenance costs and higher productivity from reduced illness and mortality rates. Further, general waste management considerations are possible through superimposing a materials-balance structure on the input-output model.

Within the broad framework of a regional impact model, the cost and benefit estimates from the computer simulation system discussed in section two above can be compared and their interactions revealed. Consequently the regional model, broadened to include political and sociological concepts where appropriate, should serve as the "ultimate weapon" in the arsenal of decision makers for the Penjerdel air pollution control region.

7. The Economic Effects of Air Pollution Control in the Region

With the very limited information presently available only limited discussion of costs and benefits of air pollution control in the Penjerdel region is possible. Nevertheless, existing indicators of costs are not ambiguous: the health benefits of abatement of pollution from SO_2 and NO_2, inferred from Dr. Hickey's report, (see the section of this Report on Relationship Between Air Pollution and Health) seem clearly justified. In terms of the known techniques of pollution abatement and and their costs, the likelihood is very remote that abatement measures which can be implemented in the next two to three years will subsequently be discovered to have been too restrictive or stringent.

The statistical association between concentration of environmental pollutants and chronic disease which has been and continues to be studied by Hickey et al is quite strong. The theoretical explanation of the statistical relation in terms of a set of mutagenic mechanisms not only goes beyond the general smoking--lung cancer linkage, but subsumes the latter as a special case. Substantial research effort on health effects is still required, as is research concerning other potential benefits from abatement in terms of reduction of aesthetic, structural, and cleaning costs. With the estimated health benefits, these benefits must all be estimated in terms of common denominator--dollars--and compared with a similar measure of costs. This comparison can be undertaken so as to infer conservatively the proper abatement level by estimating a lower limit for benefits and an upper limit for costs, and vice versa. In this way, the uncertainty with which the policymaker must deal can be established, as well as the relevant bounds for dialogue between representatives of polluting interests and "clean air" interests.

At present, it appears that the most effective analytic framework for elucidating the economic effects of air pollution abatement in the Penjerdel Region is through use of a regional input-output model. The diversity of emission sources within the region as well as the intricate physical, political, and economic relations among the agents in society dictate an explicit and systematic instrument for analyzing them. First steps toward the development and application of this tool for the Penjerdel Region are discussed elsewhere in this report. Further, this framework will serve at least initially as the basis for research through the Public Health Service to attempt to catalog and manage the costs and benefits of air pollution control.

The uncertainty which characterizes present knowledge of the costs and benefits of air pollution control strongly suggests that the initial task of legislative and administrative authority should be to avoid rigid prescription.

B. Cost Distribution Alternatives for Financing Air Pollution Abatement

There are several basic alternative methods for distributing the costs of air pollution abatement. Different financing alternatives will in general lead to different results in terms of effectiveness in improving air quality and in the use of other resources.

In such a discussion as this, and in practice, it is useful to distinguish between short term and long term financing arrangements. It must also be recognized that the incidence of taxation upon any element of society to finance air pollution abatement is the economic equivalent of imposing a liability for "cleaning up" the air upon that element; or, what is the same thing, vesting the right to "clean" air in other elements of society not so taxed. Any system of air pollution control financed wholly or substantially from the public treasury must therefore be justified ethically on the basis that each member of society is liable for air pollution damage to the same extent that he contributes to the public treasury.

Economic theory suggest that clean air, as a scarce resource in the twentieth century industrial society, must be properly rationed or it will be misused. Two assignments of liability based on alternative assignments of the "right" to use the atmosphere are here suggested. First, individuals in society are entitled to "clean" air to breathe. Hence pollution sources, and therefore ultimately their customers, must bear the cost of controlling pollution and of compensating damage attributable to pollution. Second, firms and other polluting activities have the right to use of the atmosphere, and may therefore use it for the disposal of gaseous and particulate material. Consequently, the cost of clean air must be borne by members of society.

If the latter ethical assumption is made, then financing through taxation of members of society is implied. The reverse implication is also true; a plea for public funds to finance air pollution control wholly or in part is likewise a suggestion that the public is ethically liable for the whole or part of the pollution of the atmosphere. On the basis of the pollution source liability standard in water pollution control, the ethical position assumed here is that members of society have the right to clean air.

From the viewpoint of economic efficiency, and assuming that liability for air pollution rests with the consumers of those goods and services whose production gives rise to pollution, an "optimal" allocation of resources will be reached through a system of effluent fees collected from pollution sources and transferred to damaged parties. The size of the fee paid by each source is equal to the total damage (health, structural, agricultural, etc.) caused by the marginal unit of effluent multiplied by the number of units of effluent emitted at the source.

An obvious advantage of the effluent fee system is that a strong financial incentive is provided to control air pollution at the source by the most efficient means available, whether it be process modification, installation of control equipment or, possibly, relocation.

A system of pollution control based on subsidization of the purchase of control equipment is less effective economically than a system of effluent fees in that the purchase of equipment rather than the reduction of air pollution is encouraged. If a system of control is to employ subsidies--presumably only as a transitional device since society is not presumed liable for air pollution damage--it is the reduction of pollution which should be subsidized directly rather than the expenditure to accomplish abatement. Because the measure of social benefit is proportional to the reduction in pollution, rather than the cost of the reduction, the financial incentive should be tied directly to the former. In this way, pollution sources are encouraged to search more widely for abatement methods, and to respond more quickly to advances in pollution control technology.

Thus effluent fees provide one kind of incentive to pollution control and abatement subsidies (as distinguished from expenditure subsidies) provide another. One method of air pollution control which would combine both incentives in a transitional period would be (a) the levying of effluent fees, estimated through use of a meteorological model with census tract data and (b) the use of such fees during a transitional period to subsidize air pollution abatement below the level of pollution at the onset of the pollution control program. (The subsidies would be equal to the reduction in the value of pollution damage as computed above.) Such a system would permit firms to make money during the transitional period for rapidly controlling effluents. Furthermore, such a system is self-enforcing and is in a large measure equivalent to a selective abatement program in the sense that the greatest incentives to abate would fall upon the greatest offenders, precisely those which contribute most to air pollution damage in the region.

A system of air pollution control based on legislation prohibiting or controlling pollution using fines as sanctions have been used in several metropolitan areas. Typically, a finding against the defendant (pollution source) results in appeal and suspension of further liability until one or more appellate proceedings have upheld the lower court. Hence pollution continues as do its consequent damages. The fines are normally so low as to be nominal, and not associated with the quantity of effluent or the damage done thereby, so that the largest pollution sources, to whom the fines are least significant economically, have little incentive to compliance. However, even with larger, pro rated fines, the delays from an overloaded judicial system and possible misuse of due process emasculate enforcement. Further, a system of fines would not provide financing for abatement subsidies during a transitional period to full pollution control. Any such subsidies would therefore have to be funded from public sources, which is equivalent in an economic sense to making the public pay both through the damages sustained from pollution and through taxes to finance abatement subsidies.

The "license to pollute" criticism levelled against use of effluent fees presupposes small fees. Dr. Richard J. Hickey's preliminary findings on the health effects (see section of this Report Relationship Between Air Pollution and Health) of, say, SO_2, suggest that fees based on estimated marginal damage (as suggested above) would be sufficiently high to give quite substantial abatement incentive; indeed, far more than is provided by the present patterns of legislation. There is no doubt, however, that the system of effluent fees and transitional abatement subsidy discussed here would require an uncommon grasp of the scientific and economic aspects of air pollution by the cognizant legislative body or bodies.

An alternative system of financing air pollution control without recourse to the public treasury is to levy effluent fees upon all pollutors according to the extent each contributes to total emissions. Proceeds would be used to finance a selective abatement program. The level of the total annual fee collection to be pro rated among firms would be determined by the time period allowed for full implementation of the pollution control program. An advantage of this alternative over the effluent fee system discussed above is that no meteorological model of the control area is required to estimate the contributions by each effluent source to total damage to the community. A further and critical advantage is that immediate action can be obtained, and thus immediate alleviation of a severe problem.

However, this system does substantially reduce the economic incentive for individual sources to undertake their own abatement programs and thereby diminish their effluent fees. Questions of equity also arise in the distribution of abatement expenditures among firms. These disadvantages seem to be compensated in the short run by the potential for immediate action in a selective abatement program. This system is to be preferred on economic grounds to the system of fines for noncompliance described above, because the fee system is self-financing and can be effective if properly administered. Since the monitoring requirements at the pollution sources would be substantially the same as with the effluent fee-abatement subsidy program discussed above, a combination of the two approaches might be employed in the early stages of the pollution control program, until sufficient scientific investigation were undertaken to estimate the damage attributable to each source. Fees collected on the basis of the proportionate contribution to total emissions from each source could be used to subsidize abatement by subsidizing reduction in emissions. Again, the total annual fee collections would be determined initially by the time period allowed to fully implement the pollution control program, taking into account that a damage basis for effluent fees and abatement subsidies would supplant the total emissions basis when data became available.

In view of the limited data base available in the Penjerdel Region, the total emission based effluent fee alternative seems most appropriate from an economic viewpoint for financing a program of selective abatement by the regional air pollution control authority. After the air pollution problem becomes less critical, phasing into an effluent fee system should provide more effective long-range performance.

Economic theory cannot provide an ethical basis for allocating the cost of air pollution control, but can suggest the comparative effectiveness of different financing alternatives. Strong economic incentives in the form of permanent effluent fees and interim abatement subsidies may be employed to combine both financing and enforcement of an air pollution control program for long term implementation. To obtain the greatest benefit for the least cost, air pollution damage and its reduction should serve as the basis for effluent fees and abatement subsidies respectively. An approximation to this system is obtained by substituting total emissions and reduction thereof in determination of fees and subsidies. For most effective least cost management of a severe problem such as exists in the Penjerdel Region, a short-term selective abatement program is suggested. Such a program could be financed by effluent fees levied on pollution sources proportionate to each source's contribution to total emissions in the Region.

SECTION V

A PROPOSED GOVERNMENTAL RESPONSE TO MEET AIR RESOURCE MANAGEMENT AND CONTROL NEEDS IN THE PENJERDEL REGION

Introduction

Preceding sections of this Report present the magnitude and full dimensions of the Region's air pollution problem. The single most outstanding characteristic of the problem of clearing the regional atmosphere of the tremendous amounts of contaminants it now contains is that no one of the three states or local jurisdictions can alone perform the air pollution control task.

Analysis of the state of the air pollution control art reveals that the technology is emerging, but that it is still burdened with cautious and excessively complex control tools geared more to safeguarding the present pattern of our economic and social activity than to safeguarding the quality of the atmosphere. The health impact analysis clearly indicates the real and present danger to human life in cumulative exposure to low level concentrations of airborne contaminants which are ubiquitous in the urban atmosphere at high levels of concentration. It is fair to say that present control technology, including the techniques of meteorologic analysis and air monitoring systems, is, as of now, extremely limited in its capacity for responding to the problem expressed in these terms. Moreover, even in this relatively new field of environmental control technology, there is concerted resistance to accepting the need for further massive research efforts required to confirm and elaborate these research findings of vital significance to human health. The evidence is substantial and completely persuasive for the development of public policy and viable control organizations capable of creating and implementing adequate control systems. The problem is crucial at regional, state and national levels, and the response at each level is far too cautious.

In the Delaware Valley at present, the effort to reverse the deterioration in quality of the urban atmosphere represents a massive gamble with the public health. The gamble is that the separate efforts made by state and local control agencies whose effectiveness is severely limited by inadequate legal bases, jurisdictional limitations and compromised organizational structures can collectively safeguard the public health of the Region. It is a gamble in which every citizen of the Region has a stake. Yet each citizen is at present at least partially disfranchised in making a political response to insure his own safety. None of the states or local jurisdictions can alone take action which will guarantee a safe regional atmosphere.

Analysis of the economic aspects of air pollution control indicates that the problem has deep roots affecting our entire economic structure. Management and control of the atmosphere clearly involve a consideration of the effects produced on the economy. Economic theory and pragmatics cannot dictate the value judgment as to the proper level of control. They can be utilized, however, in developing strategies to achieve such levels at the lowest total social cost. This is especially true if we are to achieve the great reduction of airborne contaminants required to eliminate the threat to human health. Much additional data and further analysis are required to implement and reflect these basic economic concerns. Cost-benefit analyses, based on the threat to human life as presented in the health impact analysis

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component of this Report, provide economic justification for the public policy decisions to develop appropriate control measures.

All of the data and research information presented thus far are clear evidence of the need for a viable regional governmental response capable of meeting the problem in terms of an interstate compact for air resource management and control implemented by a Penjerdel Region Air Pollution Control Agency created by the compact. This section of the Report provides the basis for the creation of such a compact. Justification for the use of the 11 county Penjerdel area as the jurisdiction of the recommended regional agency is presented. The basic legal requirements for effective air pollution control in a regional setting are defined. Alternative devices to control the quality of the atmosphere in an interstate region are evaluated. Specific requirements for an interstate air pollution control compact for the Penjerdel Region are outlined. A proposed Penjerdel compact, with annotations, is included in an Appendix to provide a basis for review and action by the appropriate legislative bodies.

A. Penjerdel as a Region for Air Pollution Control

1. Physical Composition and Description

Recognition of the need for a regional response to the problem of air pollution in the Delaware Valley does not automatically establish the bounds of such a region. The area encompassed in this study is the 11 county, tri-state, Penjerdel Region. It has been shown in terms of emission patterns and meteorological factors that the problem is functionally significant within the defined Region. It is also important to establish that the 11 counties are economically interrelated, and that they can be used to provide a political base for an air resource management and control system equal to the task. Penjerdel has a significant history of regional developments and activities which go far toward establishing it as an economic entity and, prospectively, as a political unit for air pollution control purposes.

Physically, Penjerdel falls within the Atlantic coastal plain and the Piedmont geological region, dividing the land into successive belts. The narrow belt of sand and silt which stretches from Trenton to Wilmington is the coastal plain, considerably narrower than Philadelphia County. The dividing line of the Coastal Plain and Piedmont regions lies a few miles west of the Delaware, bisecting the three major metropolitan areas of the Region. Rolling country west of the plain divides it from the limestone lowlands that lie further to the west. The transition from the coastal plain to the rolling country is marked by the fall line of streams, thus falls and rapids, and thus a natural site for cities at the point where ocean and river navigation must shift to land transportation.

Historically, industries and manufacturers have utilized the physical advantages of the Region. Earliest colonial emphasis was on grist and saw mills, shipbuilding in Chester and Wilmington, iron and steel in Trenton. In the early 1800's forty percent of Philadelphians were said to be engaged in manufacturing - bricks, ships, textiles, paper, and metal goods. As shipping declined, manufacturing continued to flourish; Wilmington early turned to cotton dyeing. Chemical production has dominated the economic base of the city. Throughout the 19th century the economy of the Region diversified with emphasis on textiles, boots and shoes, machine fabrication, and railroads. Penjerdel entered the 20th century as a significant manufacturing and commercial center and has remained so, though with considerable shifting of regional sources of employment. This Region, as part of the Northeast, has lost textiles and apparel but maintained major employment sectors in electrical machinery, primary and fabricated metals, and chemical manufacture, with further diversification in research and development efforts connected with aerospace, electronics, and medical and paramedical pursuits. The Region is the nation's fourth largest manufacturing center. Regional specialization has been present, however, in metal-related products, chemicals, and petroleum based products. These centuries of industrial and manufacturing diversification and affluence have inevitably brought concomitant environmental deterioration.

The Region includes most of three Standard Metropolitan Statistical Areas. The Wilmington area includes New Castle County, Delaware, and Salem County, New Jersey; the Trenton SMSA is coterminous with Mercer County, New Jersey; and the Philadelphia SMSA embraces the remaining eight counties. In total, 823 units of local government exist at present in the Penjerdel Region - 11 counties, 20 cities and towns, 218 townships, 138 boroughs, 241 school districts, and 40 other special purpose or service districts. The 1960 population of the Region, in terms of the metropolitan areas encompassed, is as follows:

Metropolitan Area	Population	Percent
Philadelphia	4,342,897	87.3
Trenton	266,392	5.3
Wilmington*	366,157	7.4
Penjerdel Region Total	4,975,446	100.0

*Excludes Cecil County, Md., which was added to the SMSA in 1966.

In land area, Penjerdel is the third largest metropolitan region in the country with 4,565 square miles. Urban area concentrated within ten miles of the Delaware River contains only one-sixth of the total regional land mass but over five-sixths of the Region's population. Considering only this urbanized strip, the Penjerdel Region "ranks as moderately dense in population" compared to other major metropolitan areas.

2. Governmental and Economic Interdependence in Penjerdel

Interdependency among jurisdictions within metropolitan areas of this nation is often assumed, but seldom empirically established. In the case of the Penjerdel Region, however, the research and planning activities of many public and private groups, projects and agencies over the past 25 years provide a broad base of evidence for regional identity and interdependence.

A recent study by the Regional Science Research Institute at the University of Pennsylvania has documented regional linkages, drawing some conclusions relevant to regional planning. Based on data on commuting patterns among the 11 Penjerdel counties, utilization of service functions provided by the City of Philadelphia, and the circulation of newspapers, the Institute concludes that "the Penjerdel region is both self-contained and cohesive."[1] Established patterns of employment were regarded as the most significant linkage, with numerous counties being heavily dependent on Philadelphia for jobs. Surplus jobs per employed resident (or county employment self-sufficiency) existed only in Philadelphia, Mercer, New Castle, and Salem counties. Philadelphia was regarded as "even more the generator of regional activity" than other individual linkage measures established.

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[1] Robert E. Coughlin, Mark Barcas, Thomas R. Hammer, and Benjamin H. Stevens, Interdependence in the Penjerdel Region, A Report to Penjerdel Greater Philadelphia Movement, and Federal Reserve Bank of Philadelphia, Regional Science Research Institute, Philadelphia, Pennsylvania, November, 1967, p. 65.

Employing various social and economic indicators, the Regional Institute Study compared Montgomery and Delaware Counties with other metropolitan areas of equivalent population to determine whether significant statistical differences existed in socio-economic structure. The conclusion was that "these counties could not be as well off if they were independent metropolitan areas."[2] The argument that Philadelphia owes much of its economic affluence to suburban-residing leadership was found less persuasive than the concept that the concentration of such leadership is the result of total regional economic opportunity. Thus, the Study suggests the possibility of suburban counties supporting central city economic and social programs by a more direct taxing route than a Federal or state government redistribution of tax revenues. Political non-acceptance of Region-wide taxing authority, the Study concludes, may create "... a difficult problem for local governments since fiscal independence in the face of economic interdependence may lead to greater state and Federal control of regional matters, and a decline in the importance of local government. The alternative is not only to increase regional cooperation but also to increase the willingness of local governments to accept part of the fiscal burden caused by regional problems."[3]

Competition by local governments for industrial tax base was criticized, however, as being far less productive economically than the overall effort to attract additional employment opportunities for the Region-as-Region. The importance of the Regional Science Study for the formulation of air pollution control policy lies in the specific documentation of the strength of economic and social interdependencies. Given these interdependencies the conclusion is clear, as stated in the Study, that the Penjerdel Region "should, to maximize its resources and serve its own interests, view itself as a single unit for planning and policy purposes." Environmental control measures will have significant economic impact and should be a part of regional planning in the Penjerdel area.

3. Air Pollution and Regional Planning

Integration of environmental control measures with regional development and planning efforts is an important part of the air resource management concept. Data developed as part of an air resource management system may provide new information and alternative approaches for regional planners. "For the planner, the information system permits a rational analysis of the air pollution aspects of proposed regional development and renewal plans such as the added effects of new sources due to increased industrialization, added population, and increased transportation activity. ... In some instances air quality standards and goals would necessitate the elimination or modification by zoning of certain activities in specific areas of the region, and... would be another factor that determine(s) the selection of land uses."[4] Several interstate and metropolitan air resource management programs analyzed during the course of this study have stressed their relationships with community plans for land use, solid waste disposal, fuel and energy supplies, and transportation. The Chicago metropolitan area air study emphasizes (1) land use planning, specifically location of larger power plants, new industrial parks, and combinations of facilities; (2) transportation patterns, primarily reevaluation of rapid transit and public transportation in central business and commercial areas; and (3) zoning and code enforcement, with emphasis on suburban deficiencies in relating these control mechanisms to pollution potential. The Northeastern Illinois Planning Commission report on air resources relates air quality to comprehensive planning by analyzing the implications of three alternate development plans to 1990 for this six county area.[5] The executive director of the Commission has elsewhere enunciated a planning agenda for air pollution control including:

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[2] Ibid.

[3] Ibid, p. 29.

- greater acceptance of stringent land use controls;
- include in the definition of blight, areas where space-heating sources result in excessive pollution levels;
- pollution control measures being applied by housing and renewal agencies before approving projects;
- measurement of air pollution effects prior to approval of new industrial plant sites;
- regulating traffic volume and location of new expressways to minimize automobile pollution.

The St. Louis air pollution study[6] suggested that all planning agencies within that metropolitan area should:

- utilize the same grid coordinate system;
- use land-use classifications applicable to air pollution emission factors, including dwelling density and space heating or rubbish emission inventories by type of land use;
- develop data cards which correlate information on the basis of parcel numbers, addresses, and grid coordinates.

In sum, these and many other studies suggest more than that air pollution control efforts must be evaluated in conjunction with other urban problems. As biology and other natural sciences are introduced into planning decisions, regional planning takes on an ecological bent. Within a metropolitan area and particularly one that cuts across state lines, the key conclusion is that only a combination of programs can succeed in improving the condition of our environment. Alternative programs that can be considered within this context are controls associated with (1) land use and zoning, (2) transportation systems, and (3) waste management control systems. Implementation of such programs depends, however, on the governmental machinery for the accomplishment of regional policy making and planning.

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[4] James D. Williams, Frederick J. Roland, and Francis L. Bunyard, Metropolitan Planning Program Relationships to Air Resource Management, National Center for Air Pollution Control, Cincinnati, Ohio, December, 1966.

[5] Managing the Air Resource in Northeastern Illinois, Planning Commission, Technical Report No. 6, Chicago, Illinois, August, 1967.

[6] Interstate Air Pollution Study, Section VIII, "A Proposal for an Air Resource Management Program."

In the designated 11 county Region, consideration of air pollution problems has been a part of the regional viewpoint of the original PENJERDEL Project, the Penn-Jersey Transportation Study and the Delaware Valley Regional Planning Commission (DVRPC). Evidences of this concern are "Clearing the Air - A Regional Challenge" published by PENJERDEL in 1963, and the 1967 "Design for Regional Planning" of the DVRPC. This RCEO study is designed to implement this concern.

Treating the question of land use and zoning, "Clearing the Air" recognizes existing decentralization of land use controls and states that "...a regional planning agency would determine at least the broad outlines for land use in the region, with air pollution effects as one of its criteria for judgment...Recommendations of a regional planning agency should also be able to provide better guidelines for the location of new towns, for making existing scattered development more compact, and for providing the buffer zones and other open spaces which will aid the dispersion of contaminants in the air." Consistent with this statement, the DVRPC Work Program asserts a strong interest in air pollution problems. Defining a "regional" problem as one which significantly affects the quality of life in a region and for which "a solution is not possible without both region-wide effort and region-oriented direction," DVRPC explains this definition with the example of air pollution. Because local governments can neither solve the problem nor speak for the whole region, air pollution becomes a problem "clearly within the competence of the regional planning agency."

In connection with regional planning and land use controls, it should be emphasized that control of land use cannot replace control of emissions at their source and should not be viewed as an alternative to point-source abatement. However, zoning and land use controls can assist in limiting the effects of air pollution. Until the technology of emissions control and the political mechanisms for implementing these controls are fully effective, land use and zoning can have a significant effect. While the Delaware Valley is frequently viewed as being intensively developed, the PENJERDEL Study projections to 1975 pointed out that "in 1960 more than half of the usable land within the Cordon Area (the 1200 square mile central one-third or urbanized portion of the nine county area) was still available for development." Given the decentralized control of land use characteristic of our political system, community land use control of environmental matters will have the most beneficial impact when coordinated with a comprehensive metropolitan-regional plan. The DVRPC, in conjunction with county and local planning agencies has the opportunity and potential for demonstrating the relevance of regional planning measures to prevent further environmental deterioration through urban sprawl.

4. Regional Transportation in Relation to Air Pollution

The emissions survey undertaken as a part of this study demonstrates that carbon monoxide, hydrocarbons, nitrogen dioxide, lead and other automobile emissions represent a tremendous proportion of the Region's air pollution. It is therefore vital to consider air pollution problems in decisions on regional highway facility and mass transit planning. San Francisco has been the primary metropolitan area to consider air pollution as an ingredient in public transportation policy. Development of public transit facilities is not an alternative to direct automotive exhaust emission control devices and efforts to improve vehicle control technology must be emphasized. As a 1965 examination of air resource management in the Bay area stated, "Although it would be unrealistic to declare that rapid transit service for the nine Bay area counties would eliminate the need to control emissions from vehicles, an effective transit system could reduce the use of private automobiles in downtown areas and, in turn, reduce air pollution levels there."[7]

The DVRPC program for mass transportation has as a basic long term objective the "coordination of transit planning with land use planning in the region." In developing "system alternatives relating transportation to alternative land use patterns," the Commission should take into account the potential benefits in reduced emissions from usage of rapid transit systems. Again, this implies no diminution of Federal and state control efforts toward reduction of automobile emissions. Mass transit and highway location decisions, however, can be of immense importance while technological complications in auto emission controls are being resolved, and of supplementary value after that time.

5. Air Pollution and Regional Environmental Control System.

This description of Penjerdel characterics and activities serves to support the conclusion that the Region qualifies as the proper geographic base for an air pollution control system and agency established by means of an interstate compact. In terms of geography, political composition, economic interdependence and regional planning activities, the Region represents a proper entity for air pollution control purposes.

There is one other dimension of the problem which is also relevant to regional concern and designation. It is well established that, properly, air pollution control is an important part of a total environmental control system. Air pollution, water pollution, and solid waste disposal are interrelated problems of an urbanized, industrialized society which must be examined in a regional context. Proposals for arresting environmental decay must be evaluated as part of a total ecological control system, and must be implemented through similar innovations in governmental structure and organization. An elite Task Force on Environmental Health and Related Problems advanced the ecological control system concept in its advice to the Secretary of Health, Education, and Welfare in June, 1967: "...one paramount conclusion results from the many diverse lines of inquiry which the Task Force pursued: an effectively coordinated environmental health protection system is mandatory, one predicated on the basic premise that the environment affects man's mental as well as his physical health and welfare. Any approach toward environmental health protection which is limited to concern for less than the total range of hazards that do or may exist in man's environment must be viewed as inadequate."[8] The National Academy of Sciences of the National Research Council, in its examination of waste management and control, concludes that systems should be designed to include all aspects of waste management and disposal on a regional or subregional basis. On the issue of governmental structure the National Academy report contends that "existing institutional arrangements must be modified and augmented to permit and encourage economies of scale and designs fitted to regional characteristics and geographic rather than political boundaries."

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[7] John A. Maga, Air Resource Management in San Francisco, Institute of Governmental Studies, University of California, Berkeley, California, 1965.

The complex interrelations of various aspects of pollution are well recognized. The efficiency of cooling towers used for water conservation are seriously diminished by air pollution; refuse dumped in flood plain areas may aggravate the possibility of floods by reducing the carrying power of surface streams; where the ground surrounding a stream is contaminated, heavy rains may increase rather than reduce the level of stream pollution. Electrical generating plants using coal as a source of power may create air pollution - by discharging sulfur compounds and fly ash directly into the atmosphere, water pollution - by filtering out much of the particulates and some of the sulphur compounds permitting this residue to be carried off by nearby rivers or streams, or solid waste pollution - by extracting the sooty materials, then drying and hauling them to a dump site. Interrelationships such as these require functional not categorical criteria for environmental control.

The constraints in this study do not permit analysis of the specific mechanisms for coordinating air pollution control with other environmental control systems. A single purpose regional agency for air pollution control established by means of an interstate compact is the basic recommendation of this study. Nonetheless, an argument for an innovative, regional governmental response to meet air quality problems is the clear recognition that such an agency can appropriately coordinate its activities, standards and regulations with efforts to meet other environmental problems. It is entirely possible that at some future date such efforts should be organizationally joined in a single regional environmental control agency.

6. Designation of the Region

The physical characteristics of the 11 county Penjerdel Region, the established economic interdependency of political units and sub-regional areas and the relationship of air pollution to such major metropolitan problems as regional planning, transportation, and total waste management control all relate directly to the issue of the designation of an air quality control region for the Penjerdel area. Appraisal of these factors supports the designation of the full 11 counties as an appropriate administrative region for air quality control. Analysis of topography shows that there is no barrier to the flow of air in a generally west to east direction across Pennsylvania and Delaware into New Jersey. The fundamental economic interdependency of neighboring counties with the core city of Philadelphia clearly implies the necessity for equivalent regulatory controls throughout the 11 county area. Efforts by Federal and state agencies in regional planning and implementation of solutions for numerous metropolitan problems have recognized the basic territorial integrity of Penjerdel as a Region. Finally, the designation of an air quality control region that does not include all of the Region's land area containing significant sources of other forms of pollution would seriously militate against a coordinated approach to total waste management in the future.

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[8] A Strategy for A Livable Environment, A Report to the Secretary of Health, Education, and Welfare by the Task Force on Environmental Health and Related Problems, Washington, D. C., June, 1967, p. 2.

As stated above, the basic recommendation of this study is for an interstate regional agency to provide substantial and equivalent enforcement authority over a region that includes the emission sources that contribute to Penjerdel's air pollution problem. To establish an air quality control region that does not include all the territory of the 11 counties examined in this study would produce an uneven economic impact and an unresponsive political mechanism within a single economic region. The potential for creation of what Governor Hughes of New Jersey has characterized as "economic havens" within a single region is obvious. No less important in the view of this study is the need to create a mechanism through which the citizens of the Region can be represented in the establishment of public policy for air pollution control. Achieving such citizen representation is the essence of developing a regional constituency. The use of county units of government as "building blocks" of a representative interstate agency which encourages the development of a regional constituency is essential.

As previously discussed, under provisions of the 1967 Clean Air Act the U.S. Public Health Service is required to designate air quality control regions in the various metropolitan regions throughout the country. It is expected that this action for the Philadelphia area will take place in the late fall of 1968 and that the region designated will be the 11-county Penjerdel Region.

B. Basic Legal Requirements for Effective Regional Air Pollution Control*

1. General Provisions

An effective air quality control program is possible only if the grant of legal powers to the responsible agency is adequate to the task. Many of the components of this necessary legal base are common to public health law and its administration generally; some are peculiar to, or at least assume special importance in, air pollution control. To stress the central significance of the legal aspects of the program is not, of course, to imply that air pollution control is simply a matter of law and its enforcement. On the contrary, the development and administration of a regional (or any other) control program is a matter of employing what are largely well-known legal doctrines and devices in a matter dictated not by legal considerations but by the nature of the problem: the types of pollution sources, the geography of the region, the existing administrative structure of government, the state of the art of pollution control, and other matters. Indeed, the legal requirements themselves must consist largely of technical standards and specifications rather than simple prohibitions; hence, as noted below, modern air pollution laws delegate the very task of determining what shall be prohibited almost entirely to the specialized control agencies. But the validity and effectiveness of these operations will depend on their having a proper legal basis.

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* The research and analysis on the legal aspects of air pollution control were performed for this study under the direction of Frank P. Grad, Associate Director, Legislative Drafting Research Fund, and Adjunct Professor of Legislation, Columbia University Law School. This section on basic legal requirements, Section C, on Federal, state and local roles, Section D, the appraisal of the interstate compact and alternative devices, and the proposed Penjerdel Compact included in this Report were prepared by Mr. Grad and John Hack, Esq., his Associate at the Fund, under the policy guidance of the Government Studies Center. Footnotes for these sections and Section E, which outlines a proposed Penjerdel Interstate Compact, appear at the end of Section E.

The essential legal authorization for any air pollution control system, whether local, interlocal, state, or interstate (or, indeed, Federal) is similar. A basic statute establishes air quality control as a function of government and provides for the establishment of an air pollution control agency (which may be an existing body, such as a Department of Health, or a division thereof). The law vests the agency with the necessary administrative powers and functions, including particularly the power to establish standards to abate and prevent air pollution, and the legal tools to carry out enforcement proceedings against violators of the laws and of its standards.

Legal questions may arise, in the development of a program and agency for air pollution control or in the administration of an existing one, with respect to any aspect of the process; for every action of a governmental agency must rest upon some legal grant of authority -- specific or general, express or implied -- and must follow constitutional requirements and other limitations on the manner of its exercise. But, as pointed out above, for many of the specialized aspects of an air quality control program, the nature of the activity is determined by technical considerations, and the legal problem is simply one of ensuring that the agency's charter is broad enough to cover the necessary programs and that there are no obstacles to the activity in other laws. For example, a comprehensive attack on air pollution is likely to require air sampling stations and other facilities. A broad grant of power is needed to ensure authority to develop and operate such facilities, since the agency is going well beyond the ordinary sphere of action of enforcement agencies, which rarely engage in operating activities unrelated to the enforcement process itself. Certain types of testing and other highly technical activities might be within the special competence of a different agency, perhaps one at a different level of government; or it might be desirable in a region with more than one agency concerned with air pollution to assign certain of these tasks to one body to prevent expensive duplication, and to conduct other activities, such as a region-wide monitoring and warning system, cooperatively. Such arrangements, which go further than the ordinary meaning of interagency cooperation, might require special authorization for the pollution control agency to in effect contract for the performance of certain tasks by other public bodies, as well as assurance that these other entities had the power to accept such an assignment.

It is chiefly in the actual task of regulation -- the setting of standards and their enforcement -- that legal considerations will largely dictate the shape of the process. The essential legal processes involved in regulation are rulemaking, provisions for hearings or adjudication, the various enforcement devices (including licensing, the issuance of orders, the imposition of civil or criminal penalties, and the power to obtain injunctions), procedures for judicial review, and such special emergency powers as may be appropriate. While these elements are familiar parts of nearly all air pollution control laws, and many of them are present in the case of nearly every administrative agency charged with regulatory functions, certain legal aspects of some of these processes require special mention.

2. Rulemaking power

The central provision of almost any air pollution control statute is a grant of power to the responsible agency to establish rules and regulations governing persons, institutions and facilities subject to its jurisdiction. These are of two types, often expressed in separate grants of statutory power. One consists of the basic substantive standards (such as limitations on the emission of specified air contaminants, requirements as to the type of equipment that may be used or the fuel that may be burned, or limitations on open fires) to reduce pollution of the air. The other consists of regulations to further the effectiveness of the substantive rules (such as requirements that emission levels be monitored, equipment tested, and records kept) as well as rules for the conduct of proceedings before the agency and other general procedural and administrative regulations.

One of the notable characteristics of modern air pollution control laws is that the applicable standards are not set forth in the law but are left to be promulgated by the agency. The statutes, in Pennsylvania, New Jersey and Delaware, and elsewhere, do not (with the occasional exception of a prohibition against pollution constituting a public nuisance, or equally vague provisions) contain any emission control requirements or other rules of law to limit pollution; indeed, they do not even set out the ambient air quality standards which the specific regulations should be designed to achieve. The power to decide what is and is not lawful is completely delegated to the rulemaking body, governed only by statements of legislative policy which are very general and offer no guidance at all as to the actual substance of the regulations. This rather striking transfer of the legislature's lawmaking power is almost inevitable in light of the nature of modern air pollution control standards, and has come to be taken for granted in this field. Several points concerning it are worthy of particular notice.

First, the almost complete transfer from the legislature to an administrative agency of the power to specify what shall be prohibited has been comparatively uncommon in most areas of law and has often been viewed with suspicion by the courts; it is however, frequently encountered and generally accepted in public health regulation, of which air pollution control legislation is a part. What is at issue here is not merely the grant of powers to an agency to implement general prohibitions or standards set by the legislature, but an authorization for the agency to write its own law; and this, outside of agencies charged with supervising specially regulated industries, is an exceptional form of delegation of power. Thus, a statute might generally prohibit false and misleading advertising and give an agency broad rulemaking powers. But in each instance a court would be able to determine if a prohibited practice involves deception or if the rule is otherwise necessary to implement the general prohibition (or, at least, whether the agency could reasonably reach such a conclusion). But when a statute simply contains a policy against pollution which unreasonably interferes with health or welfare, it has delegated the entire lawmaking function to the agency. If the agency then issues a rule limiting emissions of a certain contaminant to X parts per million, there is no way -- unless the rule is so arbitrary that it would be unconstitutional even if written into the law -- in which the court can determine if this is a proper exercise of the rulemaking power, short of setting itself up as an appellate air pollution control board with claims to the same expertise and discretion.

This type of delegation of power to air pollution agencies is not likely to be seriously challenged, because of the precedent established in the general public health field, where the grant of rulemaking power is, if anything, even more sweeping. (Indeed, if there were no special laws providing for air pollution agencies, the grant of rulemaking powers to the typical board of health would probably authorize it to issue a comprehensive air pollution code.) Thus, New York City's Sanitary Code [now the Health Code] was upheld more than a quarter-century ago by New York's Court of Appeals, which traditionally looked rather strictly upon delegations of legislative power, as a "body of administrative provisions sanctioned by the time honored exception to the principle that there is to be no transfer of the authority of the Legislature."[1] In this case, as in many others, the courts have based their conclusion that a code is valid partly on the fact that the provisions imposing a penalty for violations are in the law authorizing the code, and hence that the power to create a crime has not technically been transferred. Thus the statute provides that violations of the code are misdemeanors carrying a certain fine, or may be restrained by injunction, and so forth. In the absence of such provisions, an administrative agency cannot ordinarily prescribe what legal consequences may follow from certain acts. But so long as the legislature itself provides for the applicable penalties and court procedures, it may confer upon the administrative agency the power to set standards, that is, to determine what is and what is not lawful.

Second, acceptance of sweeping rulemaking powers is part of the more general fact that the legislative power itself exists in the most unrestricted manner in this area. Although comprehensive air pollution control codes are among the newest types of regulation, they rest not on modern concepts of the social and economic role of government, but upon its elementary duty to protect the health and safety of the public, in the light of modern knowledge as to the effects of pollution. These laws seek to prevent health hazards and interference with comfort and the enjoyment of property; they differ from the centuries-old prohibition of "public nuisances" chiefly in the recognition that harm can flow from pollution that does not necessarily consist of visible or noxious fumes or smoke. As such, the right to enact such laws is at the very core of the "police power" -- the basic authority of state and local government to regulate or prohibit private conduct when required by the public health, safety or welfare. As the United States Supreme Court said in upholding a local pollution law against a claim of conflict with Federal regulation: "The ordinance was enacted for the manifest purpose of promoting the health and welfare of the city's inhabitants. Legislation designed to free from pollution the very air that people breathe clearly falls within the exercise of even the most traditional concept of what is compendiously known as the police power."[2]

Third, it should be noted that another similarity with rulemaking in the field of public health is the delegation of power not to the department itself but to a special board. A board or commission may be used to obtain representation of the governmental units affected, as in the case of interlocal agencies, or agencies established by interstate compact with each state given representation. As in the case of boards of health, representation of the professions with expertise in the field is often provided for; but the most notable feature of rulemaking boards for pollution control has been the provision for representation of industry. While consultation with the regulated interests is an important part of the rulemaking process, particularly in matters involving the potential expense and complexity of air pollution control, this can readily be accomplished without actually giving them membership on the governing body. Indeed, the rulemaking power can be delegated directly to the enforcement agency, and specifically to its head, without establishing a formal board at all. This is now the case in New Jersey under the 1967 amendments to its State pollution control law. While administrative rulemaking is often delegated to special boards, operating either with their own staff or within a larger department, equally broad powers are often conferred on the Commission or other head of a department, who also has chief enforcement responsibilities. As long as private parties have the right to a voice in the rulemaking process, through advisory committees, hearings, solicitation of comments on proposed rules, or other devices, they can have no legitimate objection to vesting it in the enforcement agency itself.

Finally, one important result of rulemaking power in the agency, rather than in the legislature, is ability to develop new and higher standards as knowledge in the field and the technology of pollution control improve. The power to revise and improve the regulations from time to time is as important as the initial rulemaking authority. An expert agency is far more able to keep the code abreast of developments in the field than is a legislature, particularly since these developments tend to require more and more complex and technically detailed provisions as time goes on. The desirable changes could respond not only to scientific discoveries that certain contaminants pose new dangers or that certain means of control are available, but also to commercial developments. For example, if use of a better fuel or a more effective control device becomes economically feasible, standards might be raised to require it. All of these matters point to the need for a broad power to change standards, add or delete requirements, and generally amend the regulations whenever the public interest requires.

3. Licensing

One of the most important control techniques available to regulatory agencies is licensing. Basically, this is nothing more than a requirement that approval be obtained from the appropriate regulatory authority before a particular activity may be lawfully engaged in; the approval is typically embodied in a formal grant of permission described as a "license," "permit," "certificate" or similar designation. (While the terms have somewhat different origins and associations, they may now be regarded as synonymous; the entire process is described as licensure and the particular document in question may be given any label that is convenient.)[3] The standards for issuing licenses or permits may simply refer to the standards prescribed elsewhere (e.g., a provision that "the Department shall issue a permit if the equipment complies with the standards contained in this code") or it may permit the imposition of additional requirements which may involve the exercise of discretion (for example, a requirement that control equipment employ "the latest advances in the art"). In any case, the significant fact is that prior approval is required and that it is a violation of the law to proceed with the construction, operation or other activity without that approval, regardless of the lawfulness of the activity under code standards. Thus,if fuel-burning equipment may not be operated without a permit, a person who fails to obtain a permit has committed a violation, even though he shows that his equipment in fact meets all requirements of the code and that the department could not lawfully have denied him a permit.

Licensing is thus an exceptionally powerful tool for an enforcement agency. It is enabled to exercise prior control, to obtain information relating to the facilities under its jurisdiction, and in general to deal with violations of the law and disputes and misunderstandings as to its (often highly technical) provisions before rather than after they have resulted in producing the conditions that the law is designed to combat. In effect, a large part of the enforcement process is transferred from the post-violation to the pre-violation stage. The enforcement agency also has an opportunity to exercise continuing control. Just as initial construction or operation without the required permit is an "automatic" violation of law and is far less likely to take place than violations based on failure to meet the standards, so too the threat of license revocation is likely to be a far more effective deterrent against permitting future violations to develop than the mere possibility of ordinary enforcement proceedings. The very effectiveness of revocation as a virtual "death sentence," perhaps to an entire industrial installation, makes it a step that the enforcement agency will rarely if ever invoke. In some instances, as where the offending installation is a community's only public incinerator or one of its key power plants, license revocation may not be even a realistic possibility. But the institution of proceedings leading to the possibility of revocation is likely to produce a far greater impetus to at least begin corrective measures than the mere threat of even a substantial money penalty. The possibility of control provided by revocability may be enhanced by the further step of making the license good for only a fixed period, at the end of which it must be renewed. This technique might be used, for example, where periodic testing or inspection is desirable and might not otherwise take place, or where a less-than-ideal system has been permitted because of practical or economic difficulties and the department wishes to raise its standards when technological advances makes improvements possible or economical.

Licensing may also be of value to the regulated interests themselves. Prior approval gives assurance that installations that may represent a large investment will not run afoul of the law. Particularly where the applicable standards contain language that may be subject to different interpretations or that in effect gives discretion to the enforcement agency, a procedure giving advance clearance and a chance to resolve any questions as to the applicability of the standards in a given case, without hazarding a violation, may be welcome. Although issuance of a permit may or may not, depending on the particular law or procedures governing it, represent a finding of legality that is binding on the government as a matter of law, as a practical matter it assures the permit-holder that the department finds no violation as to matters covered by the permit.

Use of this technique is becoming a more and more significant element of air pollution control programs. As the importance of the pollution problem becomes more apparent and the range of regulation increases from simple smoke controls to comprehensive air quality standards, a general requirement for advance approval for the construction and operation of potential pollution sources and control devices cannot be considered an undue or excessive burden. And regulation through prior approval of plans becomes more appropriate as air pollution codes come to include regulation of the design of equipment and the manner in which processes are carried out rather than merely relying on emission controls. The result is that installations either are initially designed to comply or else will have to be substantially altered later to avoid violations. Once a facility has been built, enforcement of rules requiring changes may entail prohibitive expense and the interruption of essential processes. Thus as a practical matter, the choice may be one between prior control and no control without severe disruption and great expense.

This problem, and the consequent desirability of a system requiring prior approval, is of special importance in an area like the Penjerdel Region, where a very large portion of the total pollution emissions are the product of specific massive industrial and public utility installations. Assuring proper initial design, from an air pollution control standpoint, of a major new manufacturing operation may be of importance to an entire area. Once a major power plant is built without incorporating the latest technology, so that it is a source of pollution, the chance for effective governmental control is lessened. Policing the emissions after the plant is in operation provides no real solution to the problem.

A useful administrative device that is less elaborate than licensing is a requirement for registration, under which the party involved must notify the regulatory agency of the operation or facility in question and supply specified information, but may proceed without affirmative approval. Thus, with respect to equipment which may pose a pollution problem but for which actual testing and approval are not appropriate, the department might require that a registration form be submitted with information on its physical construction, fuel use, type of pollution control device, or any other factor it deems relevant. Failure to register, like failure to obtain a license, is per se a violation of the law or code. Since simple registration, unlike licensing, does not involve approval by the enforcing agency, it does not necessarily insulate the registered equipment from proceedings charging that it is in violation of the standards.

Registration requirements may be of value to an air pollution control agency; there may be many types of equipment of which the agency would want to be informed, but without burdening itself and the persons affected with the complications of the licensing process. The agency would be able to obtain detailed information on the potential pollution sources within its jurisdiction, obtain some of the benefits of a license or permit requirement (since requiring one to certify on a registration form that his equipment meets certain requirements is likely to be a greater inducement to compliance than the mere presence of the requirement in the code), and greatly facilitate enforcement operations.

4. The Enforcement Process

In the absence of total voluntary compliance, the effectiveness of air pollution control laws and regulations, or any other rules governing private conduct, depends upon the availability to the enforcement agency of adequate legal sanctions and remedies. Licensing and similar regulatory devices minimize the need for enforcement because the very fact that the system contains a virtually automatic sanction for violations helps ensure compliance. Conducting the regulated activity without the required authorization is in and of itself unlawful, regardless of the fact that the operation may meet all prescribed requirements, so that the violator would have been entitled to a license had he followed the prescribed procedure. Unlicensed operation is thus such a direct and visible defiance of law that it will rarely occur; the regulated interests may challenge every agency action every step of the way but they are not likely to go ahead and build a building without a construction permit or start broadcasting without a license -- or construct a factory or power plant without a certificate from the air pollution control agency, if one is required in advance.

Licensing and similar systems of requiring advance regulatory approval thus secure compliance through administrative proceedings in advance of the activity in question rather than proceedings after violations have arisen. They are thus, in a sense, largely self-enforcing, and the penalties for non-compliance ordinarily will not come into play. With respect to matters not covered by the licensing process, on the other hand, the types of sanctions available and the procedures for invoking them are apt to be of crucial importance.

Air pollution control, like other types of public health and welfare regulation, has available to it the full range of legal remedies and procedures available to law enforcement generally.[4] At the end of these procedures, and serving as the ultimate sanction for non-compliance, is some form of penalty; in the great majority of cases, under any sound system of law and administration, the role of the penalty is to deter violation and hence to make its imposition unnecessary. The speed and effectiveness of the procedures preceding it are therefore ordinarily of more importance than the nature of the penalty itself, so long as it is not a completely trivial one (this last point is of some importance in matters like pollution control, where so many of the important potential violators are major businesses for whom a small fine may have virtually no meaning).

There are, however, two matters to be noted about the nature of the penalty provided. The first is that any fine provided for should be calculated on a *per diem* basis. That is, the amount of the penalty should be measured by the number of days the violation persists; or, as it is often formulated in the statutes, each day the violation continues constitutes a separate offense. This type of fine, which is provided for by virtually all modern laws on the subject, sets severe penalties for serious violators without establishing drastic initial penalties which often result in the entire penalty provision being virtually nullified in practice. Calculating a fine on a *per diem* basis is particularly appropriate for an air pollution control law, since violation of an air quality standard is a continuing and cumulative assault on the environment rather than a single, finite act. The second point is that it may be useful to provide for a *civil penalty* instead of, or in addition to, a criminal fine for ordinary violations. Such a provision establishes a penalty but does not make the violation a criminal offense. The penalty is in effect a debt owed to the government, and it may be collected by the government in a civil action -- an ordinary lawsuit -- without the need for a criminal prosecution. This means that the special provisions of criminal law that favor defendants are not applicable. Thus, for example, the violation need not be proved beyond a reasonable doubt, but merely by a greater weight of evidence for its existence than against. The procedural complexities of the criminal process often take on special difficulty in the case of health and welfare offenses, with the courts likely to share the generally-held view that violations of these laws are not "really" crimes, resulting in great reluctance to rule against the defendant in some instances. In addition, the special weight that normally attaches to use of the criminal sanction has little meaning for violations of this type, particularly as the defendants are apt to be large or impersonal entities. Court proceedings and fines against the local power company or bus line for air pollution violations may or may not bring about compliance, but using a procedure under which the firm is found "guilty" of a "crime" does not really add anything. Air pollution codes and similar laws necessarily contain criminal sanctions, to deal with wilful violators, the making of false statements in applications to the enforcement agency, and the like; but for the ordinary day-to-day enforcement process, the civil penalty may often be more effective.

Finally, mention must be made of two procedural devices that are central to air pollution control: the power of the enforcement agency to issue orders to prevent violations, and to obtain such orders from the courts in the form of injunctions. An injunction against code violations is one of the most effective remedies the law affords, and authorization for injunctive relief is one of the essentials for an adequate air pollution control law. An offender against whom an injunction has been issued knows that definance of it is not merely another code violation but is a violation of a court order, punishable under contempt of court proceedings. Further, the injunction spells out the defendant's duty in terms that will not ordinarily be open to challenge in the contempt proceedings, since these issues have been determined in the proceedings leading to issuance of the order. In the case of an administrative order also, violation of the order is itself made punishable, not merely violation of the underlying provision on which the order is based. Courts, however, will not necessarily give an agency order the same almost automatic enforcement given to a court order. The extent to which the courts will accept the agency's finding and order as determinative, without retrying the issues examined by the agency, is one of the most complex questions of administrative law. The result may depend on the specialized nature of the problem, the degree of the agency's expertise, the extent to which the party affected had the opportunity to make his case before the agency, and many other factors, often including the extent to which the court is sympathetic to the aims of the enforcement agency and the statute it administers.[5]

Both administrative orders and injunctive orders offer an opportunity to give specific content to a general prohibition in the law, and thus tell the person affected what he may and may not do before holding him liable. Failure to do so may render the proceeding ineffective. Thus in the well-known case of New Jersey Department of Health v. Roselle,[6] the Supreme Court of New Jersey refused enforcement to an injunctive order that merely repeated the prohibition in the air pollution control code against permitting open burning of refuse, without specifying to what extent if any the operator of a refuse dump was responsible for taking steps to guard against unintentional fires. While the particular decision might be debatable as unduly restrictive of the enforcement process, the general point is clear that when confronted with a special set of circumstances falling within a very general code provision, the agency that presumably has the expertise in the matter has the duty to develop the order appropriate to the particular case. This is of value not only to the defendant but to the public interest. Where the underlying prohibition is very general, a court may be reluctant to penalize borderline violations or other conduct inconsistent with the intent of the regulation, where it is at least arguable that the conduct is outside the terms of the regulation; this will be particularly true in the case of a criminal prosecution. Properly drawn administrative and injunctive orders can make the duty of the person affected clear and specific and insure the effectiveness of the basic regulation in question.

C. Federal, State and Local Roles Under the 1967 Federal Air Quality Act

1. Evolution of the Air Quality Act

The role of the Federal government, both as a potential enforcer of air quality control standards and, even more, as an influence upon state and interstate air pollution control programs, has been significantly expanded by the enactment of the Air Quality Act of 1967.[7] The Act, a complex compromise, preserves virtually all provisions of the earlier Clean Air Act as they had been added to date, and adds authorization for gradual development of Federal standards which, if the states do not act over a period of time, will control. The original Administration proposal[8] had called for sweeping and drastic changes that would have placed both standard-setting and enforcement under Federal control. The basic proposals were two: national emission standards to combat industrial pollution, issued and enforced by the Federal government unless the states adopted and effectively enforced equal or stricter standards, and regional controls by Federally-established air quality commissions in areas requiring additional regulations. Both the national and the regional standards would be enforceable by cease-and-desist orders issued by the Secretary of Health, Education and Welfare.

The proposal to make major aspects of air pollution control the primary responsibility of the Federal government met with considerable opposition. The bill reported out of the Senate Public Works Committee, which remained substantially the same through the rest of the legislative process until enactment on November 21, 1967, provides for Federal standards only after a complex and lengthy procedure has led to failure on the part of the state to act. These new provisions have added to the existing terms of the previous Clean Air Act, which is preserved almost verbatim.

Provisions for national emission standards and air quality commissions were omitted. The Secretary is required to submit to Congress within two years of the date of the Act a detailed report on the "need for and effect of" emission standards, including a detailed analysis of the present problem, the industries and particular contaminants for which such standards would be appropriate, a cost analysis, and other matters. This provision is part of Title II, the motor vehicle standards portion of the act, which is now designated the "National Emission Standards Act" even though (except for power given the Secretary to require registration of fuels and additives) its regulatory provisions still relate solely to vehicles.

The Secretary is directed, within one year from the date of enactment, to define the Nation's atmospheric areas and, to the extent feasible within 18 months of the date of enactment, to designate air quality control regions as may be needed in the interests of improving air quality.

The Secretary shall develop and issue to the states "from time to time, but as soon as practicable" air quality criteria. Along with or subsequent to the issuance of these criteria, he shall publish recommended pollution control techniques, based on current technology and economic feasibility and including cost studies to meet the standards of air quality called for by the criteria.

2. Impact of the Federal Act on State Programs

The amendments made by the 1967 Act still leave the basic regulatory power in the hands of the States, but provide for the gradual development of Federal minimum requirements for state statutes and programs which, if not met, will cause the Federal government to step in and assume primary jurisdiction over the problem. These provisions will apply to the Federally designated "air quality control regions," such as the Penjerdel Region which require regional pollution programs. The following discussion notes some of the effects of the Federal statute on air quality control agencies and programs in the Region.

The Act operates primarily indirectly, by stimulating state action. The only provision calling for direct Federal steps to secure pollution abatement, without an elaborate procedure aimed at providing the states with every opportunity to deal with the problem is the emergency provision providing for a suit by the United States in Federal court to enjoin pollution when it "is presenting an imminent and substantial endangerment to the health of persons" and state and local authorities have been unable or unwilling to solve the problem. Aside from this provision, largely a response to the near-catastrophic air pollution condition in the Northeast on Thanksgiving, 1966, enforcement by the Federal government is only authorized as a last resort. The basic Federal role in the enforcement process is the determination of the areas of special enforcement efforts (the air quality control regions) and the establishment of minimum standards for the state air quality control programs through air quality criteria and recommended control techniques. With respect to each particular major class of pollutant, the air quality criteria are standards which the states must meet in adopting their own standards of ambient air quality, and the provisions as to pollution control techniques are standards which the states must meet in prescribing omission limitations, control devices and other enforcement means in order to achieve air quality standards.

The statute called for the initial mapping of air quality control regions by the Department of Health, Education and Welfare to take place "to the extent feasible" within 18 months of enactment, or in the late Spring of 1969. The initial designations -- including the Philadelphia region as well as the New York, Chicago, and Washington metropolitan areas -- are expected to be issued by the fall of 1968. The Department expects to issue simultaneously the initial air quality criteria and recommended control techniques. These will cover two of the chief classes of pollutants -- sulfur oxides and particulate matter.

The statute's requirements to act apply to the states only (1) with respect to any air quality control regions within their borders and only (2) with respect to classes of contaminants for which the Federal criteria and recommendations have been issued. The period given is 90 days for the Governor to certify his state's acceptance of the requirements, plus 180 days to adopt satisfactory air quality criteria, plus 180 days to adopt a program, including enforcement measures to achieve the criteria -- or 15 months in all. Thus, an adequate regional air quality control program covering the initially-covered classes of pollutants will have to be in operation not later than the spring of 1970. If a state does not meet any element of the three-stage deadline, the Department may issue air quality standards for the region, subject to the right of the state to recover jurisdiction by acting within six months after the proposed standards are issued, or to delay the imposition of Federal control by invoking a hearing procedure. If the standards, whether of Federal or State origin, are not met because of a failure of enforcement on the part of the State, the Federal Department may act against the pollution -- directly in the case of interstate pollution or with the consent of the state in the case of pollution only causing ill effects within the state of origin.

3. Impact on Interstate Programs Under Compacts.

The above is, briefly stated, the effect of the 1967 Air Quality Act on state air pollution control activities. Relationship of the Act to interstate programs and particularly to interstate pollution control agencies established by compact is somewhat more complex. The statute recognizes the importance of interstate planning and action and the fact that many of the regions on which its administration will be based are interstate metropolitan areas. The Act seeks to further the development of interstate cooperation by additional incentives, including a provision authorizing the Federal payment, for two years, of 100 per cent of the cost of planning an interstate air quality program and developing air quality standards and plans for their achievement, when carried on by an interstate body within an interstate air quality control region.

A most important provision relating to interstate compacts states the intent of Congress that no future air pollution control compact which includes jurisdiction over an air quality control region should provide for participation by any State not included, in whole or in part, in the designated region.

The effect of the Act on compacts has now been given an official interpretation in connection with Senate consideration of the Mid-Atlantic States Air Pollution Control Compact and two other interstate compacts on air pollution (the Illinois-Indiana and Ohio-West Virginia compacts). The Judiciary Committee, which has jurisdiction over compact approval, referred these to the Subcommittee on Air and Water Pollution of the Committee on Public Works, because of its special familiarity with the subject matter. In a statement and testimony on behalf of the Department of Health, Education and Welfare on March 26, 1968,[9] and in the Public Works Committee's report back to the Judiciary Committee of June 17, 1968,[10] interstate compacts are again endorsed as desirable ways of carrying out the policy of the Air Quality Act. However, the Act is construed as providing some rather specific limitations on compact activity. The Department found the three compacts in question unacceptable in their present form, largely because of incompatibility with the Air Quality Act. The Committee concurred in substantially all of the Department's objections. The Committee report recommends that Congress approve the compacts on condition that the states enact appropriate amendments.[11]

A number of the objections made were based on general considerations of effective air quality control enforcement. For example, it was stated that the enforcement agency should have the full range of powers, including the right to obtain injunctions against violations, and that pollution should be defined so as to reach potential as well as presently injurious effects. Other objections reflected the usual Congressional reluctance to commit itself to a greater extent than necessary. Proposed reservations preserve emergency powers, insure Congress's right to alter or amend its grant of consent, and provide that consent to any compact does not represent a determination that the compact agency necessarily qualifies under the Air Quality Act. These matters are not significant obstacles in the case of a well-designed compact. In certain other respects, however, the Act, as interpreted by the Department and the Committee, imposes major constraints on the structure of interstate air pollution compacts. These relate chiefly to two matters.

The first arises from the statutory provision noted above, i.e., no compact which relates to control of air pollution in an air quality control region, should provide for participation by states not included in whole or in part in such air quality control region. The Department's official position views this as an absolute requirement and also adds the converse requirement that an interstate compact must include all those states with territory included in the air quality region. Although the Act does not further state that the specific territory governed by a compact must consist solely or primarily of the designated region, both the Department and the House Committee on Interstate and Foreign Commerce (which added to the Act the language containing the limitation on compact membership) have indicated that compacts should ordinarily only cover specific metropolitan areas or groups of closely related communities which share a truly common air pollution problem.[12] The total effect of this interpretation rejects an arrangement like the Mid-Atlantic compact which was designed to cover several entire states and to include two massive air pollution problem areas, New York and Philadelphia. Thus Federal policy will bar virtually any air pollution control compact which goes substantially beyond the boundaries of a single air quality control region.

The second major effect of the Act on future compacts arises from the Department's insistence on separating the compact agency from any official tie with the Federal government. The Act, technically speaking, imposes the duties of adopting and enforcing air quality standards on the states themselves. The Department of Health, Education and Welfare is prepared to view an interstate compact agency as being the arm of the states for purposes of compliance with the Act, subject to certain requirements as to the nature of the compact as follows:[13]

a. The Federal Government is not to have voting membership in any compact. The Department deems this as a conflict of interest with its duty to subsequently pass on the adequacy, under the Air Quality Act, of the standards that the compact commission will issue. Non-voting Federal representation is considered as highly desirable.

b. The compact agency is to be an agency or instrumentality solely of the states, rather than of the states and the Federal government.

c. Despite the Compact's possible status as Federal as well as state law, standards and rules under the compact, would only have the status of enactments of the state, not of the Federal government. The principal practical effect of such a characterization is that the compact standards generally would not be binding on the agencies and operations of the Federal government.

d. Finally, since the compact machinery would be solely the creature of the states, the Federal Government would not share in financing its operations. Federal support of the operations of the compact commission would come solely through the grant-in-aid programs authorized under the Air Quality Act.

4. The Significance of the 1967 Air Quality Act for Changes in Governmental Roles

Viewing the history of Federal air pollution legislation since 1955, state governments should recognize that the next five years represent perhaps their final opportunity to maintain regulation of air pollution as a state and local government function. National legislation, including the Air Quality Act of 1967, proclaims the prevention and control of air pollution at its source to be a state and local responsibility. But the original version of the Act of 1967 with provision for Federally controlled and operated regional air quality commissions and national emission standards had a very different intent. Patterned after efforts to purify the nation's waters, the original version of the Act of 1967 would have mandated Federal intervention.

The final version of the Air Quality Act represents a compromise in which the state and local sector is given perhaps the last opportunity to exercise regulatory authority. The degree of commitment of the states in response to this challenge is the critical factor. Within the Penjerdel Region there is some increasing evidence that this challenge to state initiative is being met. The air pollution legislation and program of the State of New Jersey and the Mid-Atlantic Compact are indications of genuine state commitment. The primary defects of the Mid-Atlantic Compact have been shown to be its conflict with Federal law and policy which did not exist at the time the Compact was initiated and passed by the States of New York and

New Jersey. As a legal question, the Compact required the Federal government to join as a party before an interstate agency could be created. Interstate action must now take cognizance of new Federal policy as contained in the Act of 1967 and must be consistent with it. The question that remains is what form of interstate cooperation the states should embark on.

D. Appraisal of the Interstate Compact and Possible Alternative Experimental Devices for Meeting the Regional Problem

1. Requirements for Region-Wide Jurisdiction Established by Compact

Recognition of air pollution as a problem of the region as a whole, and recognition that its control requires overall management of a regional resource rather than just spot enforcement or improvement programs, lead to the conclusion that any effective control program, and the governmental structure to execute it, must be region-wide. In the Penjerdel Region, as in the New York metropolitan region and many other interstate urbanized areas, this means that the planning and operation of an air pollution control program must take place on a level that crosses state lines. There is little, if any, dispute on this point today. This does not necessarily mean that state, local and inter-local air pollution agencies or programs have no place. It means simply that the primary clean-air program must be as broad as the problem, and the problem is a problem of the region, not a local or even a state problem.

The further conclusion developed in this report -- that an effective air quality system for the Region calls for an interstate compact establishing an air pollution control agency with region-wide jurisdiction, adequate financing, and comprehensive powers -- represents a far more extensive transfer of power to an interstate agency than is usually contemplated by even the most comprehensive plans for the closest interstate cooperation. Interstate agencies created under compacts -- when, indeed, they have any substantive powers at all, rather than merely serving as advisory bodies or forums for exchange of views -- normally exist to develop and/or operate certain facilities in a given area that affects more than one state. This may, of course, entail extensive activities and make the interstate body -- as in the case of some port authorities and river basin development agencies -- one of the most active and visible agencies of government in its region. Entities of this type may also be given powers to make and enforce regulations, but these are incident to the facilities and areas under its jurisdiction. Thus water pollution and construction within a stream bed may be regulated by an agency governing the river basin, because the river as a public resource has been placed under its control, just as public lands may be turned over to a conservation agency as a park or preserve. And when the agency has developed and operates facilities, whether a single building or the huge trade and transportation complex run by the Port of New York Authority, the power to regulate their use follows as a natural incident to the agency's activity.

But the powers that an air pollution control agency must have are something much broader than this. It would be authorized to regulate all activities within a region embracing a significant portion of the agreeing states' territory, that may lead to air pollution. The agency would receive, in addition to its other powers, what amounts to a delegation of the general police power of the compacting states as it affects this one subject matter. While there are no necessary legal difficulties or insurmountable practical problems arising from such a development, it is probably just as well to recognize at the outset that a worthwhile air pollution control scheme for an interstate airshed does entail creation of what opponents of regional agencies often call a "super-government" -- with jurisdiction over this one field.

Creation of such an agency, it may be noted, becomes a far less radical step and indeed a natural development if air pollution control is viewed in the light discussed earlier -- not as an isolated instance of law enforcement, but as a program of conservation and management of an essential public resource. When this approach is accepted, air pollution control becomes analogous to water quality preservation and other such conservation measures. A river has always been seen as possessing a public interest, calling for the accommodation of the interests of landowners with each other and with the general good. A man does not "own" a stream running through his land in the same sense that he owns the land itself; an adjustment must be made between his interest and that of others similarly situated. The same may be said of well owners drawing on a common pool of oil or gas, or of a landowner whose excavation may undermine his neighbor's land or buildings. In each case government is recognized as having the power or duty to adjust the respective rights of those affected. To the extent that air quality control is a means of preservation of a natural resource common to the area, similar considerations apply. Actions which affect air quality are not just the concern of an individual or a municipality -- an air basin is indivisible and is the "property" of the area it covers as a unit. And as a corollary, if the airshed is interstate, the part of it over one state is not the sole concern of that state, any more than the Delaware River is the "property" of New York because it rises there. In the light of increasing concern with air pollution and developing knowledge of atmospheric patterns, air resource management is likely to be recognized, as river basin control naturally is, as an inherently interstate problem. Sweeping interstate controls -- including transfer of primary regulatory authority to an interstate agency -- then become the most natural approach, and in some situations perhaps the only possible one.

Even aside from these theoretical considerations, the practical nature of the air pollution problem leads to the conclusion that there are no real interstate alternatives: that effective regional cooperation in air pollution control seems to require a compact establishing an interstate control agency. The complexity of the problem and correspondingly of the needed regulatory code, the technically specialized nature of much of the needed rulemaking and enforcement, the need for continuing and effective enforcement (including the power to take immediate action in emergencies), and the frequency with which acts within one area cause consequences elsewhere, all lead to this conclusion. This point may be seen more clearly by examining the possible alternatives to a compact of the type being discussed here.

2. Uniform Laws as an Alternative to an Interstate Compact

A common form of interstate cooperation is the passage of uniform laws on a subject, applicable either immediately or conditionally upon similar action by another state. The problem of containing or reducing an interstate air pollution condition is, however, more complex than just a matter of getting a good law on the books in each state. It is, as has been noted, a question of continuous management and protection of a regional resource. This demands a coordinated regional program of continuing action -- planning, monitoring, research, informing and persuading, rulemaking, enforcement -- not just coordinated lawmaking at the outset. Here, even more emphatically than in other areas of administration, passage of a law is the beginning of the job, not the end. And this leads to two other points. First, regional pollution problems are notoriously likely to involve pollution sources in one part of the region causing pollution problems elsewhere in the region, often across the state line. The interests of the states, while perhaps identical in the long run, are not parallel with respect to a specific pollution problem. An effect being felt wholly or chiefly by one state may call for action by another. And in the light of prevailing winds, patterns of residence or industry, and other physical factors, the same relationship may occur regularly, and for a large range of pollutants. One state may be -- or at least be seen as -- containing the "offenders" and the other the "victims." The recurring problem will be one of enforcing in State A a series of potentially very expensive requirements imposed (at least in the immediate and tangible sense) "for the benefit of" State B. For parallel legislation to effectively protect the interests of each state in assuring effective action within the other state, some mechanism must be created to produce such action -- and presumably, in the case of an indivisible problem affecting the entire airshed, to joint action. It is not easy to see what shape such an assurance of unified enforcement, arising solely out of reciprocal laws, could take. And such a mechanism, even if it were theoretically possible, seems to be stretching the device of simple reciprocal legislation (not pursuant to compact) rather far. States do, to be sure, have numerous statutes providing for honoring drivers' licenses issued elsewhere, giving legal effect to out-of-state tax claims, and so forth, where other states reciprocate. But guaranteeing that one state will initiate its police power against a pollutor at the instance of another affected state appears to go a long step beyond this kind of reciprocity. Whether accomplished by simply imposing a duty on each state's pollution control agency or by establishing some interstate administrative mechanism, the need to assure what amounts to enforcement across state lines strongly indicates that interstate air pollution control calls for a formal agreement among the affected states -- a compact -- and not merely the de facto agreement embodied in reciprocal or parallel laws.

Second, an immediate problem arises in relation to the substantive air quality standards themselves, even aside from their enforcement. The very purpose of joint action by the states would be to ensure an adequate standard of air quality throughout the region. Part of the substance of the agreement among the states that the laws would carry out would be the provision of emission controls and other requirements strict enough to bring about the desired air quality. But air pollution control, as pointed out in some detail earlier in this report, almost necessarily requires development by an expert agency of a code, rather than enactment of the substantive standards by statute. This is a consequence of the technical complexity of the problem, the rapidly changing state of knowledge in this field, and the fact (which lies behind the regional approach) that each area's problems may require a specialized solution. There are not yet, as exist in some fields, generally accepted "model" or "standard" requirements -- although under the Air Quality Act of 1967, the first steps toward such provisions, in the form of Federal air quality criteria and recommended control provisions to achieve them, will begin to appear in the months to come.[14] In fact, of course, substantially all air pollution control laws (at least above the strictly local level) do not themselves establish standards but empower the agency to which responsibility is entrusted to do so. This is the case with the existing laws of the three states affected here, and is also the approach taken in all of the significant proposed or enacted compacts on air pollution.

This may be contrasted with, for example, the New York-New Jersey-Connecticut approach to water pollution control. The Interstate Sanitation Commission, established by tri-state compact, enforces basic standards set forth in the compact.[15] As concern over air pollution grew during the 1950's, the Commission was called on to study the problem and recommend steps. It proposed a compact extending its powers to air pollution control in a manner generally parallel to the existing water provisions, except that the standards would be promulgated by the Commission, not embodied in the legislation.[16] But if state laws can only delegate the standard-setting function, the statutes themselves cannot assure either uniformity or the protection of each state's interest in the adequacy of the other states' standards -- unless, indeed, some interstate mechanism to review and coordinate the separate codes is set up. But this again implies an interstate body or some mechanism reflecting a formal agreement among the states. In short, legislation by the several states (no matter how carefully worked out and how closely coordinated) does not seem adequate.

3. An Interstate Compact Using Existing State Agencies

Another possibility would be an interstate compact that did not set up an overall agency but merely formally pledged the states to pass laws regulating the matter in a stated fashion.[17] Such an agreement would provide the necessary assurance that each state would respect the others' interests; it could also contain provisions pledging action within one state upon receipt of a request through designated channels from another state, coordinating state codes and meeting some of the other problems noted above, as well as providing for joint steps on such matters as monitoring and warning. One objection to this approach is that it entails all of the delay and difficulty in bringing a compact into operation (such as is now being experienced in the case of the Mid-Atlantic compact) to achieve a result that merely ensures some coordination of state action. Time may show that the type of coordination achieved is not adequate or is not flexible enough to meet new conditions. Further knowledge of the causes, nature and effects of pollution and of its geographical dispersion may call for new types of coordinated action and different interstate relationships. In a compact of this type which does not set up a strong interstate body and turn over primary responsibility to it, but merely establishes a relationship between each state's agencies and pledges the enactment of certain laws, every major future change may require the elaborate process of amendment of the compact itself. Thus a compact leaving primary responsibility to the States may restrict their action just as much as would a "strong" compact of the Mid-Atlantic type, without having the latter's flexibility arising from the broad and general charter of powers given to the interstate agency. If air quality control requires a program of overall resource management with the tools and controls needed being developed as the program is carried on, rather than simply legislation followed by routine law enforcement, then this approach too is inadequate.

4. The Use of Special Authorities or Districts as an Alternative

Finally, short of creating what amounts to a new interstate level of government (which is what a truly "strong" interstate air pollution control commission approaches), an interstate public authority or special district might be envisioned, such as has been developed for many types of operating functions, as well as certain regulatory functions in limited geographic areas. Such agencies are characterized by closely defined geographical jurisdiction and grant of powers (though the sum of these powers may be quite broad). They are perhaps best known in connection with interstate bridges or tunnels, or (as in the case of the Delaware River Port Authority or the Port of New York Authority) more general port transportation and development systems including these; they also are used in river and other resources management. Regions like Penjerdel, containing interstate urbanized areas around a major river, tend particularly to produce such agencies.[18]

But a specialized and subordinate governmental entity of this type probably cannot be an effective general air quality agency because of the need for sweeping areawide rulemaking and enforcement powers. The instances in which agencies of this type are effective are usually those in which the regulatory function, vital as it may be, is both confined geographically and incident to general development and operating functions. For instance, even in a matter as sweeping as river basin development, the functions of control over water pollution, diversions, and riverside development are directly corollary to the Authority's role as prime planner and developer of the river. And even the orders of the Delaware River Basin Commission, though they may directly control the water supply and other activities of governments over a huge area, strictly speaking,only regulate what may be done to the Delaware and its tributaries. But however much an airshed may come to be viewed as resembling a watershed, jurisdiction over it means jurisdiction over all the territory in a substantial part of the contracting States, ordinarily defined as comprising a group of counties - rather than over a natural unit such as the area drained by a given river. Further, although the agency may have operating functions, they are incident to the regulatory ones, not vice versa. Air may be a resource to be managed, but the management is done chiefly by developing rules and ensuring compliance with them by all in the region, not by activities carried on by the agency itself. To do this effectively requires the powers of general government, such as lawmaking, investigation, licensing, and policing, not the operating-type powers commonly associated with other single purpose government units. Further, it should be noted that a limited type of charter, in contrast to the broad grant of jurisdiction to insure air quality and the grant of all power that may prove necessary to that end here proposed, raises again the problem of securing interstate acceptance for all future accessions of power. Even the Port of New York Authority, the oldest and most developed interstate agency and the one most often labeled a "super-government," requires the concurrence of the compacting states for it to undertake each additional activity; the result is that its plans may be delayed until a program satisfactory to both New York and New Jersey emerges. Such a veto power, whatever its merits as to development activities, has no place in pollution control.

In short, the scope and complexity of the air pollution control problem in a region like that under study here, leads to the conclusion that effective interstate action means a compact creating an interstate agency with powers broad enough to engage in all necessary air quality control activities in the region -- cooperating with the states and localities but not dependent on their future actions for its authority.

E. A Proposed Penjerdel Interstate Compact for Air Pollution Control

1. The Need for a Regional Air Resource Management and Control Agency

The central objective of this study is to determine the kind and distribution of governmental powers, controls and service functions necessary to achieve and maintain a desirable level of air purity in the Penjerdel Region, now and in the future.

The basic determinants in designing a governmental response which meets the stated objective, as documented by the various research materials developed in the study, are the following:

a. The present effort to manage and control the Region's atmosphere is fragmented and grossly inadequate, both jurisdictionally and technically, for assuring the health and general welfare of all citizens of the Penjerdel Region.

b. The jurisdictional deficiencies are basically caused by the mosaic of state and local political boundaries which divide into units a geographically related and economically interdependent region which draws upon and must control a common air mass. The present pattern of legal and administrative relationships for air pollution control activities among the states of the Region, and between the states and their political subdivisions, reflects only limited cooperative arrangements and an unclear allocation of powers and responsibilities. Collectively, these administrative and legal relationships do not and cannot provide a base for an effective response to the Region's air pollution problem.

c. The development of a stable framework of legal and administrative responsibility which can be implemented throughout the Region is vital to the effectiveness of a regional air resource management and control program. The clear need in the Penjerdel Region is for a unified program administered by a single administrative agency with adequate powers to plan, develop, and effectuate strategic air resource planning and control measures throughout the Region.

d. The technical deficiencies in the present effort to manage and control the quality of the Region's atmosphere are related to: (a) the early state of development of control technology; (b) the need to reappraise and develop new ambient air and emissions standards and regulations designed to prevent both short-term episodic and long-term cumulative health damage; and (c) the need to employ broad, strategic planning and control measures which reflect and guide the economic development of the Region and which utilize selective abatement procedures designed to achieve a safe, healthful regional atmosphere in the shortest possible time.

The basic recommendation of this study, in the light of these findings, is to urge the creation of a special interstate agency to assume primary responsibility for the development and administration of an air resource management and control system throughout the 11-county Penjerdel Region. The proposed agency and its legal and administrative mandate must be established by an interstate compact enacted by the legislatures of Pennsylvania, New Jersey, and Delaware, and approved by the Congress.

The form and nature of this proposed governmental response to meet the Region's air pollution problem should be viewed, properly, as a radical solution. In the judgment of this study, the radical nature of the recommendation is fully warranted by the research findings. The proposed response should not be viewed as a limited interstate agreement in which the three states affirm their willingness to negotiate and collectively administer a cooperative or joint interstate effort through some combination of existing state and local programs. The interstate compact proposed is more accurately described as a full and, hopefully, permanent delegation by the several states of their responsibility and authority for air resource management and control within this Region. The delegation should be viewed as a basic charter for a new level of government which is supported by both state level authority and local representation, and which is truly regional in orientation.

A proposed Penjerdel Air Pollution Control Compact is included as an appendix to this Report. This Penjerdel Compact is presented in proper draft form, with annotations to facilitate review and study by the states and earliest possible consideration for enactment. The document follows the general design of the Mid-Atlantic States Compact as the most effective compact document of those evaluated in this study. The Penjerdel Compact also reflects the results of a detailed appraisal of experience with interstate air pollution compacts throughout the nation, and the application of criteria for an effective compact. The following sections describe the appraisal and the criteria utilized.

2. Review of National Experience with Air Pollution Control Compacts

Development of the interstate compact as a legal device for integrating operational and regulatory powers over substantial area and territory governed by numerous political jurisdictions is a post-World War II phenomenon in American federalism. Interest in the use of interstate and Federal-interstate compact devices to deal with air pollution problems has resulted from (1) a mounting awareness of the magnitude of environmental deterioration, particularly by the governments in the 26 standard metropolitan statistical areas which extend into two or more states; (2) the fact that air resource management in metropolitan areas requires intergovernmental and interjurisdictional arrangements; (3) the recognition of Federal interest in air pollution control which can be assured by means of a compact; and (4) the necessity of legal and administrative linkage of the interests of Federal, state, regional, and metropolitan governmental machinery.

In the United States today there are no operating interstate compacts for air pollution, that is, compacts adopted by two or more states which have received final Congressional approval solely for control of air pollution. There are, however, several which have been enacted by states and others which have been formally proposed. All of these compacts have been examined as a part of this study.[19] Compacts which have received both state executive and legislative approval include:

(a) the Illinois-Indiana Compact, enacted in 1965 by both state legislatures, still pending before the Congress;

(b) the Ohio-West Virginia Compact, enacted in 1967 by the West Virginia and Ohio Legislatures, and also awaiting Congressional approval;

(c) the existing Interstate Sanitation Commission Compact, which has dealt with air pollution for the States of New York and New Jersey since 1961;

(d) the Mid-Atlantic States Air Pollution Control Compact which has been approved by the States of New York, New Jersey and Connecticut. Compacts which have been proposed for action include:

(a) Missouri-Illinois, and

(b) Ohio-Kentucky, drafted by the Legislative Reference Service of the Harvard Law School.

Major provisions of these compacts were examined and key elements analyzed. These include:

(a) the definition of air pollution used and its significance for evidentiary requirements under the police power;

(b) the purposes for which enacted;

(c) the general and specific grant of powers to compact agencies or administrators;

(d) the membership of the governing body including questions of representation and the decision-making process;

(e) provision for the promulgation and enforcement of air quality criteria and emission standards, and related regulations;

(f) the provisions and arrangements for governmental participation in financing operations;

(g) the relationship and accommodation of the compact's operations to existing governmental agency programs;

(h) the nature and extent of Federal participation;

(i) the question of common powers;

(j) the nature of sanctions and the enforcement process;

(k) provision for variances in enforcement;

(l) the amending process; and

(m) the duration of the agreement and conditions for return of control to the parties to the compact.

Factors affecting the strength of air pollution enforcement and control received special attention.

The necessity of scaling an innovative governmental response to meet the technical dimensions of the air pollution problem has been stressed by several significant research and public policy formulating bodies. The Environmental Pollution Panel of the President's Science Advisory Committee, the Advisory Commission on Intergovernmental Relations (ACIR) and Resources for the Future have, in their examinations of air pollution, stressed the relevance of compacts as a means of interstate action.

The diversity and range of administrative possibilities under compacts are suggested in a report by Resources for the Future: "Developing knowledge of the complex technologic and economic relationships in the sophisticated water resources management has not been matched by increased understanding of the institutional, political, and legal problems involved. Compacts are a means by which virtually any type of agency can be established. Imaginative thinking is needed about the structure of regional agencies, the range of their responsibilities, and the mechanisms by which they can be related to other public agencies and to the private sector of the economy."[20] The Resources for the Future plea for imaginative thinking repeats the call for an "imaginative adaptation of the compact idea" contained in the landmark work on compacts by Felix Frankfurter and James Landis.[21]

Both the Advisory Commission and the Environmental Pollution Panel have stressed the interjurisdictional aspects of air pollution. The ACIR concluded, in an examination of urban governmental functions, that in "areas where urban development substantially overlaps State lines, especially in major portions of the Northeast, interstate action may be the only effective way to control air pollution."[22] The Environmental Pollution Panel, in an appendix dealing with metropolitan problems stated that "...air pollution...can probably only be handled in such areas by such forms of interstate cooperation as airshed...compacts...Compacts involving these areas, covering air and, desirably, water and solid wastes as well, with Federal participation as well as State and local, would seem to be a useful mechanism to solve the intricate jurisdictional problems that now exist."[23]

3. Legal and Political Criticisms of the Compact Device

Notwithstanding the support of informed observers of metropolitan and regional affairs, the compact device has potential weaknesses which must be guarded against by careful design. Detractors and critics of the interstate compact device emphasize the procedural difficulties in creating compacts and the failure of compact administration to achieve the stated purposes of the agreement. Identification and appraisal of these difficulties, as well as legal and political criticisms, illuminate the public policy issues involved and the need for careful legal draftsmanship of the instrument.

The criticisms include the difficulties in securing agreement among participating states and other political jurisdictions, the time involved in negotiating, enacting, and securing consent, the necessity for obtaining Congressional consent, and the relative inflexibility of compacts once enacted. Given the formal and binding nature of the compact and its legal roots in the U. S. Constitution, some procedural requirements which may result in delays are inevitable. Care in compact preparation is essential since a chief weakness of compacts has been their enactment without detailed study of the problem they are intended to solve, making early amendment necessary. Moreover, careful design of the compact document can be accomplished without years of delay. Some delays associated with Federal and state review are most frequently rooted in political questions.

The chief criticisms of interstate compacts as they have been developed throughout the nation include the following:

(a) Lack of Responsiveness - individuals appointed to represent the states on compact agencies and commissions are not answerable to the electorate for their decisions. As a deliberative body, particularly in those compacts in which any state can exercise a veto on any action, it is virtually impossible to fix responsibility for action or inaction. Even responsiveness to the Governor as the appointing authority may be uncertain.

(b) Delays in Decision Making - Substantial delays in reaching decisions relating to enforcement powers in some compacts can result either from procedural requirements or from unnecessarily drawn-out appeals and clearance processes within state agencies. Procedural due process is a legal requirement; accommodation with existing state agencies is an administrative necessity. However, when such compact provisions result in postponing regulatory action for periods of six months to a year, there is a real question as to whether the intention is to achieve or prevent effective enforcement through use of the compact device.

(c) Pressures toward Unanimity and the Threat of Withdrawal of Financial Support - Decisions of compact agencies and commissions may be geared to the lowest possible level of agreement, thus limiting the possibility of firm and immediate enforcement actions. Where decisions require unanimity, effective action will frequently be sacrificed. Moreover, where a compact commission or agency has no independent power to obtain funds, and/or no covenanted agreement guaranteeing state funds, the pressures toward unanimity in decision-making may prove even stronger.

(d) State Parochialism Dominant over Regional Interests - Members of a compact commission representing a party state have the potentially conflicting responsibilities of regulating an interstate problem while also representing the interests of their state. Where these members are concerned primarily with the parochial interests of their state, and not the interstate area as a whole, unified effective regulatory activities may be difficult to achieve.

(e) Inadequate Representation of the National Interest - Logical extension of concern with a regional approach, particularly on air resource management problems, leads to the question of adequate representation of the national interest and the Federal government. To be successful, interstate compacts must be tied into existing Federal-state relations. In the air pollution field, Federal policy has been clarified by the Air Quality Act of 1967 and the proposed interstate compact must reflect the policy implications of this legislation. The 1967 Act encourages and provides financial incentives for the use of interstate mechanisms, including compacts. Geographic area covered by interstate compacts must be coterminous with the air quality control regions designated by the Federal Government under the Act. Policy interpretations of the Act require Federal membership on a compact commission, but without voting rights.

These criticisms reflect in combined form the inherent difficulties with any interstate arrangements. They may also indicate lack of full commitment toward the objective of developing effective interstate programs, defective legal draftsmanship and inadequate legal research. Despite these criticisms, however, interstate compacts constitute the most prominent and comprehensive of devices available for cooperative enforcement and regulatory action between sovereign American states. Judgments on the validity of the use of interstate compacts for solution of metropolitan and regional problems must be based on the capacity of state government leadership and initiative. The major criticisms of compacts outlined above have a common denominator in skepticism and pessimism concerning the capacity of the states to exercise authority through effective delegation and to resist bringing parochial state influence to bear on interstate regional issues.

The proposed Penjerdel Air Pollution Control Compact is designed to overcome lack of responsiveness, unnecessary procedural delays, pressures toward a lowest common denominator of consensus, and a dominance of narrow state concerns over regional resource management and control interests. It also permits representation of the legitimate interests of the national government. The Penjerdel Compact proposed in this Report is not offered simply as a politically visible alternative to Federal intervention or control. Responsibility for air pollution control cannot be left in the uncertain hands of a compact commission or agency hampered or restricted in its exercise of substantial enforcement actions.

4. Requirements for a Viable Interstate Compact

The extensive study of interstate compacts made as part of this study produced criteria for evaluating interstate compacts. These criteria suggest the necessity for and content of specific compact provisions. As previously noted, the Air Quality Act of 1967 and the hearings held by the Senate Subcommittee on Air and Water Pollution in reviewing three recently proposed air pollution compacts provide elements of both a new Federal stance with respect to interstate compacts and requirements which a new compact must reflect. The principal compact criteria developed by this study and applied as guides in developing the proposed Penjerdel Compact are presented below.

a. Definitions Included in the Compact

(1) A key ingredient of an interstate compact is the section on definitions, and most particularly the definition of air pollution, since enforcement and program efforts will hinge on how this definition is interpreted. The definition of "air pollution" presented in the compact should include language concerning all contaminants that "may or tend to be injurious." Without such language, proof of the existence of air pollution could only be established by connecting the contaminants from a specific source in one state with demonstrable injury to property or health in another. The definition should not be limited to "discharges," but should include any "presence" in the atmosphere. Most important, the definition must permit preventive action and not require proof of injury before abatement action can be taken.

(2) Definitions included in an air pollution compact should be of sufficient detail to accurately reflect modern control technology, and to provide a base for enunciation and explanation of a comprehensive air management and enforcement program. There must be an adequate framework established for enunciation of air quality standards and emission regulations required to accomplish this purpose.

b. Compact Agency Organization and Administration

(1) In the administration of an air pollution compact, the regulatory, enforcement, and operating responsibilities should be exercised by a single regional executive or compact administrator and the compact commission. Responsibility for administration of an interstate compact by existing state agencies, or by compact administrators who are state air pollution officers, is inappropriate to the regulatory and enforcement powers, duties, and functions that should be assigned the regional agency.

(2) The air pollution commission should be composed of members chosen solely as general representatives of the state and regional jurisdictions. No provision should be made for ex-officio members from either (1) those holding an official position in the pertinent state regulatory agency or (2) those representing major industry groups being regulated. With membership restricted to general representatives, the total number of commissioners representing a single state should be limited to the minimum number which provides adequate representation of the state and the region.

(3) In response to this organizational criterion, the Penjerdel Compact proposes a staged organizational plan. It provides an initial period of two years in which the Compact Commission would consist of the Governors of Pennsylvania, New Jersey, and Delaware, or their appointed designees, and a Federal representative as a non-voting member. After the initial period, the proposed Compact provides for the expansion of the Commission to include one representative elected at large by the electorate in each of the three state areas included within the jurisdictional boundaries of the Compact. This means that the second Pennsylvania member of the Commission would be elected by the voting residents of the five Pennsylvania counties included in the Penjerdel area (Bucks, Chester, Delaware, Montgomery and Philadelphia). Similarly, the second New Jersey Commission member would be elected from the counties of Burlington, Camden, Gloucester, Mercer and Salem; and the second Delaware member would be elected from New Castle County. The ultimate voting membership of the Commission would thus be six, two from each state. The Executive Director of the Compact agency would be ex-officio member of the Commission, but without a vote.

The device of staged organizational composition and elected representatives is designed to meet the twin objectives of (1) achieving early organization of the proposed compact agency and (2) insuring the development of regional representation at the policy-making level.

(4) No state represented on the Compact Commission should be permitted to exercise an absolute veto power either through voting mechanics, or by a boycott of the Commission meeting. A majority consisting of four members, but including two gubernatorial

designees, should be sufficient for quorum and policy decisions of the Commission. The present Federal policy on interstate compacts requiring that each state have only one vote defeats any effort to develop a regional constituency and should be waived in the case of the proposed Penjerdel Compact. The membership and voting provisions are designed to stimulate the development of policy cohesiveness and to insure that neither the gubernatorial designees nor the elected regional representatives can be systematically out-voted by bloc voting patterns.

(5) Representatives of official state agencies or major industries or associations may be utilized as members of advisory technical boards to the compact agency or commission.

c. Jurisdiction of the Compact Agency

Territorial jurisdiction of the Compact should be defined in terms of specific units of general government, specifically counties, in each of the party states. In this study, sufficient research and analysis has been completed to define the dimensions of the air pollution problem in terms of the 11 county Penjerdel Region. Provisions should be made for extending, by amendment, the jurisdiction of the Compact to abutting or surrounding territory which the compact commission finds affected by air pollution sources within the compact area.

d. Powers and Duties of the Compact Commission and Executive Director

(1) The Executive Director of the Compact Agency and the Compact Commission should have the power to establish or provide for uniform standards, enforcement, and a common procedure and policy for the granting of variances for the entire Compact region. The Compact Agencyshould have authority for establishing air quality and emission standards, delineating districts or air sheds for control purposes, classifying air contaminants, establishing warning systems, and, after informing the Governors of the party states, exercising emergency powers.

(2) Of the many powers which a compact agency must possess, the following are most critical:

- the power to issue, enforce, and obtain compliance with, orders, rules, and regulations;
- authority to maintain an adequate system of air pollution enforcement including, but not limited to, (1) registration and reporting requirements, (2) licensure of new and existing installations, and (3) the establishment of fuel standards.
- provision for operating monitoring and other facilities and providing technical assistance.

(3) It is essential that the Executive Director of the Compact Commission be provided a substantial role at the policy-making level.

Under the Penjerdel Compact, the Executive Director should be appointed for a fixed term by joint action of the governors of the three states, and reappointed by majority vote of the Compact Commission. Dismissal from office should be permitted for cause after public hearing. The Executive Director of the Penjerdel Compact should be empowered to:

- prepare standards, rules and regulations for Commission review and approval;
- grant permits and licenses, with Commission review on appeal;
- enter into contracts for services, subject to Commission review and approval;
- establish a personnel system and salary classification plan based on merit principles, and hire and dismiss employees required to discharge the duties of the Commission.

e. Sanctions Available to the Commission

Provision should be made for the establishment of civil, criminal and injunctive sanctions which can be imposed on violators of commission regulations and standards. For the purpose of invoking sanctions under the Compact each day should represent a separate offense or violation.

f. Concurrent Jurisdiction with Compact States

(1) More restrictive or stringent state codes, laws, or statutes should be permitted, with provision for review of such standards.

(2) The Commission should have the power to intervene in every proceeding which in any way relates to the air pollution control standards in the Compact region.

g. Relations with Existing Agencies

(1) Provisions dealing with coordination and cooperation between a new interstate agency and existing agencies will normally be scattered throughout the articles of a compact. But where a compact calls for substantial operating powers, as in the case of the Penjerdel Compact, these relationships should be made as clear and specific as possible. Where it is intended to utilize services of existing agencies, such action should be explicitly stated. The basis and source of authority for resolving conflicts between enumerated powers of the Commission and the residual powers of existing state and local agencies should be stated.

(2) In the proposed Penjerdel Compact, the Commission is specifically designated as the primary air pollution control agency of the Region. Its powers and responsibility are intended to be superior

to any other governmental agency operating in this functional area. These powers are not negotiable except by states party to the Compact in accordance with the terms of the agreement therein represented.

(3) Provision should be made for the Compact Commission to organize and designate, at its pleasure, sub-regional air pollution districts and to establish relationships, including purchase of service contracts, with local and state governments for the provision of air resource management and control services. The Commission should recognize local initiative in the development of sub-regional services and programs, but the option to establish such districts should remain with the Commission.

h. Financial Support for Compact Operations

(1) It is essential that the compact organization receive adequate financial support for its operations through a mechanism which does not jeopardize its independence of policy and action.

(2) Ideally, the Compact Commission should be granted limited taxing power applicable in the jurisdictions served. At the least, the Commission should have the power to allocate its operating expenditures in accordance with equitable formulas of cost distribution among the local governments served, or the state governments which are party to the compact.

(3) In the Penjerdel Compact, provision is made for the allocation of operating expenses in accordance with equitable cost sharing formulas, including the power to assess costs in accordance with the equalized value of assessed taxable real estate in the various counties served.

i. Coordination with Other Regional Environmental Agencies

(1) Control of the atmosphere is but one element of a concern for the total regional environment. Moreover, it is well recognized that management and control of the atmosphere are inextricably related to the problems of water pollution and solid waste disposal. A total ecological perspective is required in managing and controlling the Region's atmospheric resource. It is likely that in the near future this perspective, properly, will produce coordinated, perhaps unified, ecologically oriented planning and control programs.

(2) The proposal to establish a Penjerdel Air Pollution Control Compact is warranted, in the judgment of this study, by the urgency and seriousness of the air pollution problem. Toward the end of developing a coordinated approach to total environmental control, the Compact requires the Commission to engage in research involving the relationship of air resource management to the total ecology, to keep other agencies and the public informed of its research activities, and, specifically, to seek consultation and, when appropriate, review of its standards and control technology

by the Delaware River Basin Commission, the Delaware Valley Regional Planning Commission, and other agencies concerned with natural resource allocation affecting the ecology of the Penjerdel Region.

5. The Need to Build a Penjerdel Regional Constituency

The posture and orientation of an interstate compact agency might reflect merely a continuing mechanism to represent, negotiate and extend a protective administration of sovereign state interests in any given field. At the other extreme, a compact can reflect a complete and virtually permanent delegation of state responsibility and sovereign authority toward obtaining specified administrative objectives in a designated geographic area. The compact agency, in this second case, can operate with considerable flexibility and administrative latitude within the general constraints set in the enabling legislation. This is clearly an accurate characterization of the type of agency proposed in the Compact to manage successfully the Penjerdel regional air resource. The development and imposition of planning measures and positive controls to achieve a livable atmosphere for more than five million citizens of the Region cannot be a matter of continual negotiation between and among the states or localities, nor can the individual planning, management and control actions of the administrative agency created be subjected to veto of the Compact member states if improved air quality is to be achieved. The traditional legal safeguards against capricious and arbitrary actions of governmental agencies are, of course, required; but they should be applied with no greater stringency nor frequency because the agency is the creation of an interstate compact.

In essence, the proposed Compact, and the administrative agency through which that Compact can be implemented, should seek to create and stimulate the development of a total regional constituency, in the political sense of the word. This means, simply, that the citizens, governmental jurisdictions, business, industrial and civic interests and agencies throughout the Region must come to understand that the seriousness and functional requirements of the air pollution problem demand regional control measures. That understanding must be reflected by a responsiveness and support through normal political channels. Effective air resource management and control, as well as water quality control and adequate solid waste disposal systems, will not emerge unless there is political support for the essential measures as they are applied at the sources and processes which produce a polluted environment. There is legal commitment to this cause at the Federal and state levels of government. There must be local consensus and support exercised through regional mechanisms as well. This is why this Report stresses the development of a regional constituency through elected representation and financial commitment along with the establishment of primary power and responsibility in a regional agency. Sponsorship and implementation of this study by the Regional Conference of Elected Officials, with the active assistance of all other concerned public and private agencies, offer the best hope that the objective can be achieved.

Notes to Section V
(Legal Analysis Components)

B. Basic Legal Requirements for Effective Regional Air Pollution Control

1. People v. Blanchard, 228 N.Y. 145, 42 N.E.2d 7 (1942).

2. Huron Portland Cement Co. v. City of Detroit, 362 U.S. 440, 442 (1960).

3. See Grad, Public Health Law Manual, 54-56 (1965).

4. See generally Ibid., Chapters 9-14, describing the various legal penalty and enforcement devices as they relate to public health law generally.

5. Compare Commonwealth v. Heindel, 42 Pa. D. & C.2d 205 (1967) reversing a conviction for violating an order of Pennsylvania's Air Pollution Commission because of the Commission's failure to comply with prescribed administrative procedures, with Shahmoon Industries, Inc. v. Department of Health, 93 N.J. Super. 272, 225 A.2d 699 (1966), upholding an order despite a less-than-perfect procedure, upon finding the "public policy" of New Jersey's air pollution control law to "militate against further delay in the processing of this case."

6. 34 N.J. 331, 169 A.2d 153 (1961).

C. Federal, State and Local Roles Under the 1967 Federal Air Quality Act

7. Public Law 90-148, 81 Stat. 485 (approved Nov. 21, 1967). The Act, like all recent Federal air pollution control laws, is in the form of an amendment to the Clean Air Act, 42 U.S.C. §§1857-1857l, originally enacted in 1955.

8. S. 780, 90th Cong., 1st Sess. (1967).

9. Hearings on Air Pollution Compacts Before the Subcomm. on Air and Water Pollution of the Senate Comm. on Public Works, 90th Cong., 2d Sess., pp. 459-66 (1968).

10. Senate Committee on Public Works, Recommendations to the Committee on the Judiciary Regarding the Conditional Consent of the Congress to Various Interstate Air Pollution Control Compacts, 90th Cong., 2d Sess. (1968).

11. Ibid., pp. 3-4 & Appendix A (giving proposed "conditions to Congressional Consent").

12. H. R. Rep. No. 728, 90th Cong., 1st Sess. (1967), p. 24.

13. Hearings, supra note 9, at 464, 466.

D. Appraisal of the Interstate Compact and Possible Alternative Governmental Devices for Meeting the Regional Problem

14. This situation may be contrasted not only with the ordinary instance of reciprocal state laws, which follow nationally-promulgated models, typically designated as "uniform laws", but with building and housing codes, where the standards are incorporated into the statute rather than being left to the agency to formulate. The Department of Housing and Urban Development, in requiring localities to enact codes as part of the "workable program for community improvement" required by §101(6) of the Housing Act of 1949, permits and indeed expects all but the largest municipalities to adopt one of the standard "model" codes developed by national organizations in the building and housing field. Thus the decision to enact a code on a given subject is almost automatically to choose the applicable "model."

15. The compact contains not merely a general statement of policy in favor of clean waters, but specific provisions as to the level of abatement to be secured. See Article VII of the compact, prescribing in detail the percentage of contaminants of various kinds to be removed from certain waters.

16. The amendment failed of passage, and ultimately provisions were enacted giving the Commission a role in air pollution problems largely limited to research, persuasion, and recommendation. N. Y. Public Health Law §1299-1; N. J. Rev. Stat. 32:19A-19. These provisions have been repealed, effective upon the coming into force of the Mid-Atlantic States Air Pollution Control Compact.

17. The compact noted above, setting up the [New York-New Jersey-Connecticut] Interstate Sanitation Commission, and the 1939 compact (now superseded by the Delaware River Basin Compact) to control pollution of the Delaware, are really of this type, even though they set up interstate agencies. In each case the agency does not have comprehensive powers, and the standards are set out in the compact itself or pledged for later enactment by the States.

18. So many such agencies have appeared in recent decades that New Jersey's code of laws has an entire division (Title 32) dealing with "Interstate and Port Authorities and Commissions." Much of this legislation deals with the Delaware River. The number of different compacts, amendatory compacts, uniform laws, and other laws on similar subjects illustrates vividly how regional problems tend to outgrow agencies with narrowly limited powers.

E. Air Monitoring Systems and Technology

19. Working papers presenting the details of this analysis are available through the Government Studies Center, Fels Institute of Local and State Government, University of Pennsylvania.

20. Resources for the Future, Report #24, "Some Highlights of 1966", January, 1967.

21. Felix Frankfurter and James M. Landis, "The Compact Clause of the Constitution," 34 Yale Law Journal 685, (May, 1925).

22. Performance of Urban Functions: Local and Areawide, The Advisory Commission on Intergovernmental Relations, (Washington, D. C. , September, 1963), p. 23.

23. Restoring the Quality of our Environment, Report of the Environmental Pollution Panel, President's Science Advisory Committee, (Washington, D. C.: November, 1965), pp. 62, 65.

PROPOSED

PENJERDEL AIR POLLUTION CONTROL COMPACT

Introductory Note

This draft compact is designed to implement the basic recommendation of this Report providing for an interstate air pollution control agency for the 11-county Penjerdel Region. The compact consists of the text of the Mid-Atlantic States Air Pollution Control Compact, with certain modifications. The changes are those necessary or appropriate (1) to provide for and reflect the change from a compact agency dealing with all of the states that comprise the Northeast urbanized region to one operating in a single tri-state metropolitan area, (2) to increase and clarify the powers and independence of the agency, (3) to meet certain objections of the Federal government and enable the compact agency to operate effectively under the Air Quality Act of 1967, and finally (4) to provide certain modifications and formal improvements in the compact structure. Although the tri-state agency provided for would be a rather different entity in many ways from the Mid-Atlantic Commission, the compact set out here is simply the Mid-Atlantic Compact with the revisions noted, not a new document. The working and arrangement of the prior provisions, as well as their substance, have been followed except where changes as noted above, or stylistic or conforming amendments, are called for.

Use of the Mid-Atlantic States Compact as a basis for a new interstate arrangement permits discussion to focus on the new and revised elements in a document that has already received a great deal of attention and considerable approval. The Mid-Atlantic Compact is, at this time, the strongest and best interstate air pollution arrangement that has yet been developed; and it has been generally accepted as such even where specific provisions have been criticized. Its legal and political acceptability is shown by its actual enactment by three states in 1967 - including New Jersey, one of the three Penjerdel states. The Compact's current indefinite future is almost entirely a result of the fact that its approach became somewhat obsolete with the enactment of the Air Quality Act of 1967. The objections raised to the Compact by the Department of Health, Education, and Welfare relate almost entirely to its compatability with the Act and the Department's interpretation thereof - particularly in its coverage of the entire area of several states, rather than a single Air Quality Control Region, and in its provision for Federal voting representation on the Compact Commission. The Department's view are set forth in the testimony of Deputy Under Secretary Dean W. Coston, and Statement of the Department submitted for the record, at the Senate hearings on S. 470, S. 2350, and S.J. Res. 95, March 26, 1968. The testimony and related material appears at pages 459-480 of Hearings on Air Pollution Compacts before the Subcommittee on Air and Water Pollution of the Senate Comm. on Public Works, 90th Cong., 2d Sess. [hereinafter cited as 1968 Compact Hearings]. The formal statement of the Department's position on the compacts and the criteria it applies, is at pp. 463-66.

The detailed notes which accompany the compact in the Report explain the significant points at which this draft compact differs, section by section, from the Mid-Atlantic States Air Pollution Control Compact. A few minor changes in language and some of the conforming amendments made necessary by substantive amendments elsewhere, are not noted. (Note that, because of the insertion and deletion of sections, the numbers of the later sections in some of the articles do not correspond with those in the prior compact.) Since this draft contains only the compact text itself, without preambles or formalities of enactment, one point of importance appears only implicitly: This compact, unlike the Mid-Atlantic Compact, is designed as an agreement among the three Penjerdel States (which Congress approves, pursuant to the Constitution), but without making the Federal Government a party. The Mid-Atlantic Compact, following the notable precedent of the Delaware River Basin Compact, was drafted as a Federal-interstate compact--that is, one to which the Government of the United States was itself a party. The difference reflects the fact that the commission under this draft compact is the agent solely of the party states, not of the Federal Government, and the reluctance of both Congress and the Department of Health, Education and Welfare to accept Federal participation without detailed safeguards against implicit Federal commitments. The actual effect of the difference is not great. First, Congressional approval of an interstate compact entails essentially the same process of legislation as actual Federal participation. Secondly, the nature of the Federal role on any compact commission and the commission position under Federal law is determined by the substantive provision of the compact, and the language and departmental interpretations of the Air Quality Act, not by whether the United States is a party to the compact.

Proposed

Penjerdel Air Pollution Control Compact

ARTICLE I

SHORT TITLE, DEFINITIONS AND FINDINGS

§ 1.1 Short Title

This Compact shall be known and may be cited as the "Penjerdel Air Pollution Control Compact."

§ 1.2 Definitions

For the purposes of this Compact, and of any supplemental or concurring legislation enacted pursuant thereto, except as may be otherwise required by the context:

(a) "Commission" means the commission established by this Compact;

(b) "Region" means the Penjerdel Air Quality Region established by section 2.1 of this Compact;

(c) "Federal Government" means the Government of the United States and, as the context may require, any agency or instrumentality thereof;

(d) "Signatory State" means the State of Delaware, the State of New Jersey, and the Commonwealth of Pennsylvania;

(e) "Air contaminant" means dust, fumes, mist, smoke, or other particulate matter, vapor, gas, odorous substance, or any combination thereof;

(f) "Air pollution" means the presence in the outdoor atmosphere of one or more air contaminants in such quantities and duration as is or tends to be injurious to human health or welfare, animal or plant life, or property, or would unreasonably interfere with the enjoyment of life or property;

(g) "Emission" means a release into the outdoor atmosphere of air contaminants.

§ 1.3 Findings of fact

It is hereby found and declared that;

(a) The tremendous growth of population and industry has resulted in substantial increases in atmospheric waste and air pollution over the entire Region;

(b) Air pollution does not respect political boundaries, and persons far removed from its sources and having no responsibility for or control over its creation endure health hazards, discomfort and inconvenience and experience property damage and economic loss;

(c) Air pollution is associated with chronic disease mortality rates for major categories of cancer, cardiovascular diseases, vascular diseases of the central nervous system, and congenital malformations, with serious risks to health from these chronic diseases resulting from long-term exposure to sub-acute levels of pollution;

(d) It is necessary and desirable to abate existing air pollution and prevent future air pollution so as to secure and maintain air quality which is consistent with the public health and welfare, the propagation and protection of plant and animal life, and the protection of property and other resources of the Region;

(e) In the present state of the art, there are no public facilities for collection and disposal of atmospheric waste comparable to facilities to cope with liquid and solid waste, and the effects of emissions differ greatly among air resource uses and users, under the various meteorological and geographic conditions, which disregard state boundaries;

(f) The Region designated by this Compact, because of its geography, atmospheric characteristics, and nature and distribution of pollution sources, constitutes a unit for purposes of air quality control and constitutes an air quality control region under the Federal Air Quality Act of 1967;

(g) Effective air quality control for the Region requires a tri-state agency with broad powers to develop and execute a comprehensive program, including the establishment and enforcement of air quality standards, emission controls, and other needed regulations.

§ 1.4 Existing agencies; construction

It is the purpose of the signatory parties, to the extent not inconsistent with this Compact, to strengthen the role of existing agencies of government in air pollution control, and to further cooperation among them as well as between them, the Federal Government and the Commission established hereby.

§ 1.5 Cooperation on overall environmental problems

It is the intention of the signatory parties, recognizing the close relationship between air pollution control, water pollution control, solid waste disposal and other aspects of environmental control within the Region, to coordinate to the greatest extent possible the activities of State and regional agencies, including the Commission created by this Compact, having such responsibilities within the Region. To this end:

(1) The Commission shall inform the Delaware River Basin Commission of its proposed standards, rules, and regulations and, to the maximum extent possible, cooperate with the Delaware River Basin Commission, other regional agencies and the agencies of the signatory States having responsibilities related to environmental controls;

(2) any agency of the signatory States or any political subdivision thereof having responsibilities for water pollution control or solid waste disposal shall cooperate with the Commission, including consulting with the Commission in advance of undertaking major activities which may affect the responsibilities of the Commission;

(3) the signatory States, may, by future concurrent legislation, confer upon the Commission responsibilities in fields of environmental control related to its initial responsibilities, not inconsistent with the terms of this Compact.

ARTICLE II

AIR QUALITY CONTROL REGION AND AIR QUALITY COMMISSION

§ 2.1 Penjerdel Air Quality Control Region

There is hereby established a Penjerdel Air Quality Control Region, consisting of all of the territory within the following political subdivisions: in the State of Delaware, the County of New Castle; in the State of New Jersey, the Counties of Burlington, Camden, Gloucester, Mercer and Salem; and in the Commonwealth of Pennsylvania, the Counties of Bucks, Chester, Delaware, Montgomery and Philadelphia.

§ 2.2 Commission created

There is hereby created the Penjerdel Air Quality Commission as a body politic and corporate, with perpetual succession as an agency and instrumentality of the respective signatory States.

§ 2.3 Commission membership

(a) Initial organization. Until December 31 of the second calendar year following the year of the effective date of this Compact, the Commission shall consist of the Governors of the signatory States. Each member shall appoint an alternate, with power to attend all meetings of the Commission and to vote in the absence of the member. Each alternate, unless otherwise provided by the law of the signatory State, shall serve during the term of the member appointing him, subject to removal at the pleasure of the member. A member may appoint a person to serve as his alternate during the temporary absence or disability of the latter.

(b) Permanent organization. On and after January 1 of the third calendar year following the year of the effective date of this Compact, the Commission shall consist of two members from each signatory State, one representing the government of the State and one representing the portion of the Region located within the State. The State representative shall be the Governor or his alternate, as provided in subsection (a) of this section. The local representative from each State shall be elected for a term of four years by the people of the counties comprising the portion of the Region within the State, in such manner as shall be provided by the law of the State. The Secretary of State of each signatory State shall certify to the Commission the result of each such election.

(c) Transition provisions. The change in the composition of the Commission provided for in subsection (b) of this section shall not affect the continuity of the Commission as a corporate entity or the continuing validity of any act of the Commission taken prior to the effective date of such subsection (b). An alternate serving immediately prior to the effective date of subsection (b) shall continue to serve without reappointment, as the alternate to the State representative pursuant to subsection (b). The signatory States agree to take all legislative and other actions necessary to implement this section and to enable the Commission to organize itself pursuant to subsection (b) thereof as of the effective date of subsection (b).

§ 2.4 Federal representative

There shall be a representative of the Federal Government to the Commission, who shall, unless otherwise provided by Federal law, be designated by the President of the United States and serve during his pleasure. Such representative shall not be a member of the Commission and shall have no vote upon its actions. Subject to this limitation, the rules of the Commission shall accord to the Federal representative such privileges in connection with its proceedings, including where appropriate the right to participate in its deliberations, as will assist him in his role of coordinating the activities of the Commission with the air pollution control policies and programs of the Federal Government.

§ 2.5 Compensation

Members of the Commission and alternates shall be reimbursed for necessary expenses incurred in and incident to the performance of their duties. A person, other than the Governor of a State, serving as or in place of a member shall in addition receive a sum fixed by the Commission, to be not less than $100, for each day of such service.

§ 2.6 Voting power

Each member shall be entitled to one vote on all matters which may come before the Commission. No action of the Commission shall be taken at any meeting unless a majority of the membership, including (on and after the effective date of section 2.3(b)) a majority of the State representatives, shall vote in favor thereof.

§ 2.7 Organization; procedure

The Commission shall provide for its own organization and procedure and shall adopt rules and regulations governing its meetings and transactions. It shall organize annually by the election of a chairman and vice-chairman from among its members. It shall provide by its rules for the appointment by each member in his discretion of an advisor to serve without compensation, who may attend all meetings of the Commission and its committees.

§ 2.8 Executive Director

(a) The Commission shall appoint an Executive Director, who shall be the chief executive officer of the Commission and shall have all of the powers and privileges of a member of the Commission, except the right to vote. He shall serve for a term of five years and shall be eligible for reappointment. He may be removed during his term of office only for cause, by majority vote of the Commission after notice and hearing before the full Commission. The Commission shall fix the compensation and, subject to subsection (b) of this section, establish the powers and duties of the Executive Director.

(b) The Executive Director, in addition to any other powers granted to him by or pursuant to this Compact, shall have the power and the duty to:

(1) prepare standards, rules and regulations for Commission review and approval;

(2) grant permits and licenses, subject to review on appeal by the Commission;

(3) enter into contracts for services, subject to Commission review and approval;

(4) establish, under general policies set by the Commission, and administer a personnel system and compensation plan for Commission employees based on merit.

The Commission may delegate to the Executive Director any of its powers except the power to adopt and amend standards, rules and regulations, the power to approve a budget and apportion the sum required to balance it, and the power to establish, and delegate powers to, District Air Pollution Control Boards under section 2.9. The Commission may require that any power of the Executive Director be executed subject to its approval.

§ 2.9 District air pollution control boards

The Commission may, on its own initiative or on request of the governing bodies of one or more units of local government with the Region, designate air pollution control districts within the region and establish District Air Pollution Control Boards for such districts. Such Boards shall be constituted as the Commission shall provide, including, to the extent the Commission deems appropriate, representatives from the units of local government within the district. The Commission may delegate such of its powers as it deems appropriate to the Boards for exercise with their respective districts, but no District Board shall have the power to establish an air quality standard or emission control requirement that is less restrictive than a standard or requirement of the Commission applicable within the district. The Commission may provide that exercise of certain powers of the District Boards shall be subject to the approval of the Commission or its Executive Director. No delegation of power to, or action of, any District Board shall limit the powers of the Commission, and the Commission may at any time rescind any such delegate or abolish any such Board. The Commission shall adopt provisions for the financing and staffing of the Boards, which may, with the consent of units of local government within the district, provide for financial contributions by, and use of personnel of, such governmental units.

§ 2.10 Jurisdiction

The Commission shall have, exercise and discharge its functions, powers and duties within the Region. It may by contract or otherwise act jointly, concurrently, or in cooperation with any other agency or instrumentality of government within or without the Region for the purpose of effectuating the purposes of this Compact.

§ 2.11 Retained jurisdiction of signatory parties

(a) Nothing in this Compact shall limit the right of any State or local government to enact or enforce laws, rules or regulations not inconsistent with this Compact, or with any standard, rule or regulation of the Commission; and any such State or local law, rule or regulation may be more restrictive than any requirement in effect pursuant to this Compact.

(b) The Commission shall have the right to intervene in any judicial proceeding brought by or against any air pollution control agency or officer with jurisdiction within the Region. Such agencies shall, to the extent that the Commission may prescribe, notify the Commission whenever the validity, construction or effect of any provision of the Compact or any rule or regulation adopted thereunder, is at issue in any judicial or administrative proceeding.

ARTICLE III

POWERS AND DUTIES OF THE COMMISSION

§ 3.1 General powers

The Commission shall:

(a) Investigate the causes and sources of air pollution, identify air contaminants, and provide for research and the compilation and analysis of information relating thereto;

(b) Develop comprehensive plans and programs to improve and maintain the air quality of the Region;

(c) Establish standards for air quality and requirements for the control of emissions of air contaminants to abate existing air pollution and to prevent future air pollution, subject to the provisions of Article IV of this Compact;

(d) Promote, sponsor and conduct technical, educational and research programs and projects to identify and evaluate air contaminants and to develop and apply methods, systems and procedures for the abatement and prevention of air pollution;

(e) Enforce or provide for the enforcement of this Compact and rules and regulations lawfully promulgated thereunder; and

(f) Furnish technical services, advice and consultation to agencies of the signatory parties, provided that the costs of such services may be reimbursable whenever the parties deem appropriate.

§ 3.2 Auxiliary powers

In furtherance of the powers and duties elsewhere prescribed in this Compact, the Commission may:

(a) Sue and be sued in any court of competent jurisdiction;

(b) Have a seal and alter the same at pleasure;

(c) Acquire, hold and dispose of real and personal property by gift, purchase, lease, license or other means, and accept grants and comply with the conditions thereof;

(d) Provide for the organization and administration of a Commission staff; retain and employ counsel and private consultants on a contract basis or otherwise; and establish such temporary or permanent advisory committees, with such powers, as it may find useful in the exercise of its functions under the Compact;

(e) Have for its members and its properly designated officers, agents and employees, the right to secure full and free access and entry to all property, premises and places in the Region, in accordance with the applicable provisions of the Constitution of the United States, and the constitutions and laws of the respective signatory States, for the purpose of making inspections or enforcing the provisions of this Compact; and no person shall obstruct or in any way interfere with any such member, officer, employee or agent in the making of such inspection, or in the enforcement of the provisions of this Compact or in the performance of any other power or duty under this Compact; and

(f) Cooperate with and receive from any department or agency of any of the signatory parties, or of any political subdivision thereof, such assistance and data as will enable it properly to carry out its powers and duties, and may authorize and request any such department or agency, with the consent thereof, to execute such of its functions and powers as the public interest may require;

(g) Take by condemnation such real property as may be necessary to its purposes, such right to be exercised pursuant to the laws governing such takings by the signatory State in which the property is located, unless such State otherwise provides;

(h) Construct, improve, maintain, transfer to any other public body, or otherwise dispose of such physical facilities as may be needed in the exercise of its functions;

(i) Exercise any other corporate power, not inconsistent with the provisions of this Compact, as may be necessary and proper to the exercise of its duties and functions under this Compact.

ARTICLE IV

AIR QUALITY STANDARDS AND EMISSION CONTROL REQUIREMENTS

§ 4.1 Generally

(a) In order to abate existing air pollution and to prevent and control future air pollution in the Region, the Commission shall prepare and develop standards of air quality and emission control requirements for the Region as required to protect the public health and welfare and prevent air pollution which would unreasonably impair the beneficial use of the air of the Region. To this end, it shall encourage and conduct studies, investigations and research relating to air pollution and its causes, prevention, control and abatement.

(b) For the purpose of such standards, the Commission may establish and delineate subregions within the Region, seasonal requirements, and classifications of air contaminants by type and source, for general or selective application of such standards and emission controls.

(c) Prior to the adoption of standards or emission control requirements, the Commission shall hold public hearings upon due notice of the proposed standards, and all interested persons shall be given an opportunity to be heard at such hearing. After such notice and hearing, the Commission may adopt and from time to time amend and repeal standards in the form of rules and regulations to prevent or control future air pollution and to abate existing air pollution, and to require the installation of such measures, systems and procedures for the abatement or prevention of air pollution as may be required to protect the public health, safety, property rights, and general welfare. Any such rule or regulation, amendment or repeal thereof shall take effect not less than sixty days after its adoption by the Commission and filing as required by law.

(d) Rules and regulations adopted pursuant to this section may provide for the imposition of effluent charges and other charges on the emission of contaminants.

§ 4.2 Monitoring; warnings, emergencies

(a) The Commission shall provide for a uniform, comprehensive and integrated system for monitoring atmospheric waste in the Region, the measurement and forecasting of air pollution, and the identification of significant meteorological, geographical, and ecological factors within the region, its districts or airsheds.

(b) The Commission shall establish and administer warning and alert procedures and systems with respect to impending and existing conditions of immediately dangerous air pollution.

(c) The Commission may provide by rule for the exercise, during emergency conditions, of any power not inconsistent with the provisions of this Compact. Such rules may authorize the temporary imposition of more restrictive requirements upon activities regulated by the Commission (including, where necessary, orders for the cessation of activities contributing to hazardous pollution), the delegation of powers of the Commission to officers thereof, the issuance of emergency rules and orders without prior notice or hearing, and such other powers and procedures as the Commission may find necessary and proper. The Commission may, by agreement with State and local agencies within its jurisdiction, provide for cooperative action in emergencies, including the assumption by the Commission of powers of such agencies and the delegation to the agencies of powers of the Commission.

§ 4.3 Permits

The Commission may by regulation require that permits be obtained before the construction or operation of designated types of potential pollution sources, control devices, or other facilities, where it finds such provision necessary to the control of air pollution. Such regulations may include requirements for advance approval of plans and specifications, testing (under the auspices of the Commission or otherwise), periodic renewal and/or inspection requirements, or other necessary provisions. The Commission may, to the extent it deems necessary, impose such requirements upon the continued operation of existing devices or facilities.

§ 4.4 Enforcement

The Commission may, after such notice and hearing as shall be provided for by its rules, issue an order or orders to any person or public or private corporation, or other entity, to cease and desist from any emissions which it determines to be in violation of such rules and regulations as it shall have adopted for the prevention and abatement of air pollution. Any such order or orders may prescribe a schedule, including a reasonable time for the construction and installation of any necessary systems, methods and procedures, on or before which the emission of air contaminants shall be wholly or partially discontinued, modified or treated, or otherwise required to conform to the standards established by the Commission. Any court of competent jurisdiction shall have jurisdiction to enforce against any person, public or private corporation, or other entity, any and all provisions of this Compact or of any such order. The Commission may bring an action in its own name in any such court of competent jurisdiction to obtain temporary restraining orders and temporary and permanent injunctions, to compel compliance with any provisions of this Compact, or of any rule, regulation or order issued pursuant thereto, according to the practice and procedure of the court.

§ 4.5 Hearings; subpoenas

(a) The Commission shall establish by appropriate regulation the procedure to be followed in the conduct of its hearings. Neither the Commission nor any person designated by it to conduct a hearing shall be found by common law or statutory rules of evidence or by technical or formal rules of procedure in the conduct of such hearings.

(b) The Commission, or such member or officer of the Commission as may be designated by the Commission for that purpose, shall have the power to issue subpoenas to compel the attendance of witnesses and the giving of testimony or production of other evidence, and to administer oaths in connection with any such hearing. It shall be the duty of the Commission or of such member or officer of the Commission as it may designate to issue subpoenas at the request of and on behalf of any party to a hearing before the Commission. Subpoenas issued by the Commission shall be enforced by any court of competent jurisdiction of the signatory parties, according to the practice and procedure of the court applicable to subpoenas issued in proceedings pending before it.

§ 4.6 Penal sanction

Any person, association, or corporation who violates or attempts or conspires to violate any provision of this Compact or any rule, regulation or order of the Commission duly made, promulgated or issued pursuant to this Compact, in addition to any other remedy, penalty or consequence provided by law, shall be punishable as may be provided by statute of any of the signatory parties within which the offense is committed. In the absence of such provision any such person, association or corporation shall be liable to a penalty of not less than fifty dollars and not more than one thousand dollars for each such offense, which the Commission may recover in its own name in any court of competent jurisdiction, and in a summary proceeding where available under the practice and procedure of such court. For the purposes of this section in the event of a continuing offense, each day of such violation, attempt or conspiracy shall constitute a separate offense.

§ 4.7 Judicial review

Any order or determination of the Commission under this Compact shall be subject to judicial review in any court of competent jurisdiction as may be provided by the law of the respective signatory States. In the absence of such provision, such review shall be governed, to the extent not inconsistent with the provisions of this Compact, by the general provisions for judicial review of administrative action applicable to orders and determinations of the existing air pollution control agencies of statewide jurisdiction of the respective signatory States.

ARTICLE V

PROCEDURE AND ADMINISTRATION

§ 5.1 Powers of the Commissioners

The commissioners, subject to the provisions of this Compact, shall:

(a) Serve as the governing body of the Commission, and exercise and discharge its powers and duties except as otherwise provided by or pursuant to this Compact;

(b) Determine the character of and the necessity for its obligations and expenditures and the manner in which they shall be incurred, allowed and paid subject to any provisions of law specifically applicable to agencies or instrumentalities created by compact;

(c) Provide for the internal organization and administration of the Commission;

(d) Appoint or provide for the appointment of the principal officers of the Commission and delegate to and allocate among them administrative functions, powers and duties;

(e) Let and execute contracts to carry out the powers of the Commission.

§ 5.2 Regulations; enforcement

(a) The Commission may make and enforce reasonable rules and regulations, in the form of an air pollution code or otherwise, for the effectuation, application and enforcement of this Compact. Any rule or regulation, other than one which deals solely with the internal management of the Commission or a rule operative solely during the duration of an emergency and issued pursuant to section 4.2(c) of the Compact, shall be adopted only after public hearing and shall not be effective unless and until filed in accordance with the law of the respective signatory parties applicable to administrative rules and regulations generally.

A certified copy of any such rule or regulation, attested as true and correct by the Commission, shall be presumptive evidence of the regular making, adoption, filing and publication thereof.

(b) The Commission may designate any officer, agent or employee to be an investigator, and such person shall be vested with the powers of a peace officer of the State in which he is duly assigned to perform his duties.

§ 5.3 Confidential information

Any records or other information furnished to or obtained by the Commission in the exercise of its powers, functions and duties from any private person, corporation or other entity which records or information, as certified by the owner or operator, relate to production or sales figures, or to secret processes or production, or which if made known to others would tend to affect adversely the competitive position of such owner or operator, shall be retained solely for the use of the Commission and its employees, in the administration and enforcement of this Compact, and for the use of air pollution control agencies of the signatory parties in the administration and enforcement of State or Federal law, and shall not be published or disclosed for any other purpose by any officer or employee of the Commission or any other person without the written consent of such owner or operator.

§ 5.4 Meetings; records; reports

(a) All meetings of the Commission shall be open to the public.

(b) The minutes of the Commission shall be a public record open to inspection and copying at its offices during regular business hours, subject to the law relating to public records of the signatory States in which such minutes are located.

(c) The Commission shall make and publish an annual report on its programs, operations, and finances (including such recommendations as it deems appropriate), to the Governors and legislative bodies of the signatory States and the Congress of the United States. It may at any time make such additional reports, and issue such other publications, as it deems appropriate; and it shall seek by all feasible means to increase public knowledge of its programs, its rules and regulations, and air pollution and its control generally.

§ 5.5 Prohibited activities

(a) No commissioner, officer or employee shall:

1) be financially interested, either directly or indirectly, in any contract, sale, purchase, lease or transfer of real or personal property to which the Commission is a party;

2) solicit or accept money or any other thing of value in addition to the compensation or expenses paid him by the Commission for services performed within the scope of his official duties;

3) offer money or any thing of value for or in consideration of obtaining an appointment, promotion or privilege in his employment with the Commission.

(b) Any officer or employee who shall wilfully violate any of the provisions of this section shall forfeit his office or employment.

(c) Any contract or agreement knowingly made in contravention of this section shall be void.

(d) Officers and employees of the Commission shall be subject in addition to the provisions of this section to such criminal and civil sanctions for misconduct in office as may be imposed by the law of the signatory State in which such misconduct occurs.

§ 5.6 Audit

The Commission shall provide for an annual independent audit of its accounts and financial transactions by a certified public accountant, and for the publication of the report of such audit, as part of its annual report or otherwise.

§ 5.7 Tort liability

The Commission shall be liable for the negligent acts or omissions of its officers and employees, acting within the scope of their employment, to the same extent as a private employer, but no liability shall arise from (1) the exercise of discretion vested in such officer, even if the discretion be abused, or (2) acts or omissions, using due care, pursuant to the provisions of this Compact, other laws, or a rule or regulation, whether valid or invalid.

ARTICLE VI

GENERAL PROVISIONS

§ 6.1 Commission budget

The Commission shall annually adopt a current expense budget for each fiscal year, and shall apportion the amount required to balance the expenditures therein, less estimated revenues from all sources, to the signatory States in proportion to the total equalized assessed valuation of taxable real property in that portion of the region contained within each State. Each signatory State shall annually certify to the Commission such equalized total for the counties of the Region therein, which certification shall be conclusive. Following the adoption of its annual budget, the Commission shall transmit certified copies of the budget to the budget officers of the respective signatory States at such time and in such manner as may be required under their respective budgetary procedures. The signatory States covenant and agree to include the amount so apportioned for the support of the Commission's current expense budget in their respective budgets next to be adopted, subject to such review and approval as may be required by their respective budgetary processes. Such amounts shall be due and payable to the Commission in equal quarterly installments during the Commission's fiscal year. A signatory State may by law provide that the counties or other units of local government within its portion of the Region shall reimburse the State for its annual contribution to the Commission, but no such law shall relieve the State of its obligation to the Commission under this section of the Compact.

§ 6.2 Cooperation

Each signatory State pledges faithful cooperation in the control of air pollution in the Region. Consistent with such object, each signatory State pledges to enact (or if enacted, to keep in force and where necessary to amend) laws which will:

(a) Enable it to secure and maintain standards of air quality at least equal to those prescribed by the Commission;

(b) Accomplish effectively the objectives of this Compact, and enable its officers, departments, boards and agents satisfactorily to accomplish the obligations and duties assumed by the party under the terms hereof; and

(c) Enable it to provide technical and administrative services to the Commission upon request, within the limits of available appropriations, and to cooperate generally with the Commission for the purposes of this Compact, provided that the cost of such services may be reimbursable whenever the parties deem appropriate.

§ 6.3 Withdrawal from Compact

(a) A signatory State may withdraw from this Compact by enacting a statute repealing the same, but no such withdrawal shall become effective until two years after the Governor of the withdrawing State has given notice of the withdrawal to the Commission and to each Commissioner.

(b) No withdrawal shall affect any obligation of a signatory State or any person therein accruing prior to the effective date of the withdrawal, nor any order of the Commission issued prior to such effective date or any proceeding initiated for the enforcement thereof. The jurisdiction of all appropriate courts and agencies for the enforcement of any such order shall continue, notwithstanding the fact that the effective date of the withdrawal may have passed.

§ 6.4 Status of Commission under Federal law

The Commission shall not for any purpose be deemed an agency or instrumentality of the Federal Government except as may be specifically provided by Federal statute.

§ 6.5 Amendments and supplements

Amendments and supplements to this Compact to implement the purposes thereof may be adopted by legislative action of any of the signatory States concurred in by all of the others.

§ 6.6 Construction and severability

If any provision of this Compact, or the applicability thereof to any signatory State, agency, person or set of circumstances is held invalid, the validity of the remainder of such Compact and the applicability thereof to any other signatory State, agency, person or circumstance shall not be affected thereby. The provisions of this Compact shall be reasonably and liberally construed.

§ 6.7 Effective date; execution

This Compact shall become binding and effective thirty days after its enactment by the State of Delaware, the State of New Jersey, and the Commonwealth of Pennsylvania, and its approval by the United States Congress. The Compact shall be signed and sealed in four duplicate original copies by the respective Governors of the signatory States. One such copy shall be filed with each of the signatory States in accordance with the laws of the State in which the filing is made, and the remaining copies shall be filed and retained in the archives of the Commission upon its organization.

Penjerdel Air Pollution Control Compact

Section by Section Annotations

§§ 1.1, 1.2, 1.3: The changes in language in these sections from their predecessor sections in the Mid-Atlantic Compact reflect the most basic substantive change, the restriction of the compact area to the Penjerdel air quality control region other than the entire area of the compacting states, which, if all five states to which the Mid-Atlantic Compact was open joined it, would cover a large part of the entire Northeast urbanized area. One basic consequence of this change, reflected in several of the amendments in these and the following sections, is that a commission for such a specific region is clearly to be the primary air pollution control agency for the area under its jurisdiction. Thus language in the Mid-Atlantic Compact relating to the retention of general jurisdiction in existing agencies and the Commission's duty to operate through them, however appropriate it may have been in the case of a commission covering a vast area embracing several air pollution problem areas, is out of place here. (For example, compare § 1.3(g) with former § 1.3(f). Note that new section 1.3(f) refers to the unitary nature of the compact area and specifically to its designation as an Air Quality Control Region under the Air Quality Act of 1967.)

§ 1.4: The revision of this provision derives from the change in emphasis noted above, under which the Penjerdel Compact Commission assumes primary responsibility for air pollution control in its area, making inappropriate a directive to work through existing agencies to the greatest extent possible. Utilization of state and local agencies, however, remains broadly authorized by section 2.10 and other provisions, and this section as rewritten makes interagency co-operation and the strengthening of existing bodies, consistent with the Commission's role, one of the legislative purposes of the compacting parties. See also section 1.5.

§ 1.5: This section is new. It supplements section 1.4 by putting into more concrete form the general policy of co-operation and co-ordination stated therein, and by extending it from the field of air pollution alone to the broader area of environmental control generally. Air pollution control affects and is affected by governmental activities dealing with solid waste disposal (both public performance of the service function and regulation of private activity), water quality control, and related matters. Indeed, these areas are being increasingly recognized as aspects of a single problem--controlling man's impact on the ecology of his surroundings, particularly in densely populated, highly industrialized centers like the Penjerdel Region. This section calls for the greatest possible co-operation among the Penjerdel Commission, the Delaware River Basin Commission, other regional bodies (such as the Delaware Valley Regional Planning Commission) and relevant State and local departments. Included in this mandate is a requirement that the Penjerdel Commission be informed of actions to be taken by other agencies that may be of concern to it, and that it in turn furnish them with its proposed standards and other regulations. While the Commission will no doubt find the comments of other agencies of great value, it should be noted that this latter provision in no way subjects rulemaking or other activities of the Commission to any requirement of approval (or other action) by any other body. Further, this section leaves open the possibility that it may be appropriate at some future time to extend the responsibilities of the Penjerdel Commission into areas of environmental control beyond, but related to, air quality control; it permits such expansion of the Commission's role by simple concurrent legislation, without the need for a Compact amendment.

§ 2.1: This section, the most basic new provision of the compact, defines the compact area as the 11-county tri-state area surrounding Philadelphia. Section 1.2 of the former compact defined "region" to include the entire area of the party states; section 1.2 of this draft defines the term by reference to this section. Thus, the rest of the document, including in particular section 2.10 defining the Commission's area of jurisdiction as the "region," reflects the change without the need for amendment. The words "air quality control region" are used in the name assigned to the area to emphasize the close relationship between the compact and the Air Quality Act of 1967, which uses this term for the areas to be designated for its purposes - one of which is the area herein defined.

§ 2.3: This section provides for a transition from a Commission composed of the Governors of the party States (or their designees) to one including representation for the areas of each State within the Region. For the first two years of its existence (and until the end of the calendar year in which the anniversary falls) the Commission will consist of the three Governors or their alternates. Following this initial period, the Commission will have two members from each State - the Governor, or his alternate, and a representative elected from the counties of the Penjerdel Region lying within the State. The Commission's natural constituency, those within the area subject to its regulation and for the benefit of which its activities are principally intended, will thus be represented. (The special obligations of the States--as the parties to the Compact, and as the entities upon which the Federal Air Quality Act operates - are, however, reflected in the provision for voting power. See Section 2.6 and the notes thereto.) The States undertake, as part of their obligation under the Compact, to enact the necessary legislation and take any other needed steps with respect to the local representatives and their election far enough in advance to permit the Commission to begin operations under its revised structure immediately upon the effective date of the changeover.

§ 2.4: This section, providing for non-voting Federal representation on the Commission, has been drafted to reflect the firm opposition of the Department of Health, Education, and Welfare to full Federal membership on interstate air pollution control commissions, such as that provided in the Mid-Atlantic Commission. The Department views Federal representation as desirable, but deems a Federal vote on such commissions as inconsistent with its duty to pass upon the validity, under Federal standards, of the standards and programs developed by compact commissions. 1968 Compact Hearings, pp. 461, 464. Provision for Federal voting membership is one of the bases for the Department's inability to accept the Mid-Atlantic Compact as passed by the States. 1968 Compact Hearings, pp. 462, 465. This section provides for a Federal representative with no vote and explicitly provides that he is "not . . . a member of the Commission." He is, in effect, a delegate "to" the Commission, rather than a Federal representative "on" the Commission. This, while largely a matter of form, reinforce the emphasis in the Compact that the Commission is not a Federal instrumentality (see section 6.4), an approach stressed by the Department. 1968 Compact Hearings, p. 466. The Compact leaves the representative's role almost entirely to be worked out by the Commission and the Federal government, empowering the Commission to the extent appropriate to deal with him as a member in all but name and vote. The section provides that the representative would be designated by the President, as envisioned by the Department (1968 Compact Hearings, p. 464), but provides that Federal law may at any time supersede this provision. Thus the powers of Congress are not impaired, but the effectuation of the Compact need not await their exercise. If, as seems likely, compacts with a similar Federal role are developed for other interstate air quality control regions, Congress may wish, by amendment to the Air Quality Act or other general law, to provide for the designation of representatives and their role in relation to the compact agencies and the Federal government.

§ 2.6: This section preserves the provisions for equal voting rights among members and for the affirmative votes of a majority of the total membership upon any action requiring a vote; it adds a provision that when local representatives have been added to the Commission, such a majority shall include a majority of the State representatives. This requirement recognizes the special role of the government of each of the party States in activities under the Compact. It is the States which are the parties to the Compact and as such have pledged to each other their cooperation in air quality control in the Region. And it is the States upon which the Air Quality Act imposes the task of enacting and enforcing adequate standards and regulations in the Region, if Federal pre-emption is not to occur. The States may do so through the compact agency—indeed, this is one of the basic reasons for the creation of the Commission—but it is still to the States that the Federal government looks for compliance, and it is the Governors thereof who must certify to the Federal officials that the Federal criteria will be met. The local representatives, by contrast, although they do speak for the interests of the Region itself, have no such relationship and are responsible only to the local electorate. It is therefore appropriate, in the light of their peculiar responsibilities, that the Governors or those who speak for them on the Commission be protected by the special voting requirement added to this section.

§ 2.8: This section is added to increase the effectiveness and continuity of the Commission's operations by substantially strengthening the position of Executive Director. The actual operating activities of a public agency (particularly one whose work is of as specialized and technical a nature as that of the Commission) requires a single, strong executive—even where, as here, ultimate authority rests with a governing board. The stature and authority of the Executive Director are increased by the provisions of this section specifically designating him as the chief executive officer of the Commission, making him in effect a member of the Commission (without a vote), and providing for his removal during his term only for cause and after formal notice and hearing. In addition, this section confers directly upon the Executive Director some of the basic administrative functions of the Commission and authorizes it to delegate any additional powers, excluding only the final exercise of its most basic legislative and fiscal powers. Even as to these, however, the fundamental technical operations of preparation will ordinarily fall to the Executive Director and his staff. Note that the section provides that as to certain activities the Commission must, and as to any others it may, retain a power of review and approval over the acts of the Executive Director.

§ 2.9: This section is new. It authorizes the creation, as the Commission deems appropriate, of districts within the Region. The Commission may establish local boards for such districts and delegate to them, with respect to their districts, such of its powers over the Region as it may see fit. Special problems of local areas, and the potential role of local government and interlocal cooperation, are thus recognized. Local governments may request Commission action setting up a local board and, where appropriate, may conduct part of their own activities through such boards. The Commission has, however, complete discretion to act, on local request or on its own initiative, or refrain from acting in any given instance. Even where a local board has been created, the Commission retains power to require approval of its acts, exercise any of its own powers which may entail overriding local acts, and withdraw powers from the local boards or abolish them. And in no instance may a local board take any action that would have the effect of lowering a Commission standard or requirement. These protections are necessary to ensure the continued supremacy of the Commission within the Region, as required by its duties under the Air Quality Act and the obligations of the signatory States under this Compact.

§ 2.11: The predecessor to this section, § 2.8 of the Mid-Atlantic Compact, imposes limitations on the Commission that unduly hamper its authority, particularly in its role as the primary air pollution control agency for the region. Prior subsection (a), specifically denying powers of licensure, is omitted; the Penjerdel Commission, as part of its broad grant of powers, is authorized to require licensure. See section 4.3 and notes.

Subsection (a) of this section is from former subsection (b) without substantive change; subsection (b) of this section is new and is designed to enable the Commission to protect its interests and those of the compact and regulations issued under its authority in proceedings involving state and local air pollution control agencies in the region. Any reference to retained powers, whether in terms such as "not inconsistent," "more [or: not less] restrictive" or any other formula, is difficult to apply, especially to matters as technical as modern air pollution control requirements. Courts face a particular problem when, as often happens, the rule in question does not simply duplicate the governing rule or make an existing provision stricter, but adds new matter or approaches a regulation on an entirely different basis. See, *e.g.*, Borough of Verona v. Shalit, 92 N.J. Super. 65, 222 A.2d 145 (1966), *aff'd on other grounds*, 96 N. J. Super. 20, 232 A.2d 431 (1967), invalidating a local ordinance regulating emissions on a basis involving a broader prohibition than the State's air pollution code (before the governing state statute was amended to permit more restrictive local provisions). Permitting the agency itself to intervene, to present the authoritative interpretation both of its codes and of the technical meaning of "inconsistent" and "more restrictive" in the particular context, and to otherwise aid in the orderly development of the law, should be of great value to the courts. The Commission would be permitted both to check improper incursions by state and local agencies into its authority, and to aid such agencies (some of which may be less well equipped than the regulated interests to engage in complex litigation) when these matters are contested in an effort to defeat or delay the proper exercise of state and local jurisdiction. An example of this approach is presented by laws governing the Federal courts (28 U.S.C. § 2403) and certain states (*e.g.*, N.Y. Executive Law § 71, N.Y. CPLR § 1012(b)), which provide for notice to the Attorney General, and his intervention in defense of the statute, when a constitutional challenge is raised in a suit to which the Government is not a party. Rule 24(b) of the Federal Rules of Civil Procedure provides that the Federal courts may permit Federal or state agencies to intervene when a statute or rule (not necessarily the constitutionality thereof) becomes involved in a non-governmental suit; and various laws grant such rights to certain specific public agencies. This subsection is similar, but it places the burden on the state or local agency involved. The Commission has complete discretion as to the types of issues of which it is to be notified, and as to when to intervene. Note that the notification requirement relates to questions of the construction and effect of Compact provisions and rules, as well as their validity, and that it applies to proceedings before the agencies themselves as well as court actions. It thus covers questions arising under subsection (a) as well as any other question under this Compact that may arise in a proceeding before a local agency. The right to intervene is not restricted to cases covered by the following sentence, but extends to any court proceeding involving an air pollution control agency or officer within the Commission's jurisdiction.

Subsection (c) of the corresponding section in the prior compact has been omitted. It is not clear how the Compact could "affect" employer-employee relations, or specifically to impair industrial safety regulations. Although a pollution code provision and an industrial health requirement may be related, they are hardly likely to conflict in the sense that one affirmatively requires what the other prohibits so that they cannot stand together. Since compliance with both is possible, the person regulated is not given a dispensation by one from obedience to the other; the effect of the several statutes is cumulative rather than conflicting. Such laws are therefore saved by subsection (a) of this section, particularly since they relate to subjects of regulation which the Compact makes no attempt to transfer from the States to the Commission. In the light of these considerations, there is no need for a special savings provision for these regulations; indeed, its only effect might be to imply that the state authority in similar fields that overlap with pollution control (for example, building codes and general health codes) is not preserved, which is clearly not the case.

§ 3.1: The Commission's duty to develop comprehensive plans for the Region's air quality (particularly significant in the light of the new Federal legislation) is made explicit; this reference replaces mention of plans and programs to effectuate the standards, matters which are covered by the rest of the compact. The planning provision precedes the standard-setting provision in the interest of logical sequence, without implying that the development, promulgation, and enforcement of standards must await the development of the regional plans.

§ 3.2: Subsection (d), establishing the power to provide for staff, counsel, and consultants, is expanded to cover the power to establish and utilize the services of advisory committees as well. These committees may be of considerable use in the light of both the technical nature of the Commission's task and its intergovernmental aspects. While the Commission would almost certainly have the power to set up such groups even without explicit authorization, particularly in the light of the "necessary and proper" clause added to this section, it seems useful to set out the provision in this subsection which deals with analogous matters. It is thus clear that the Commission may properly use its funds to pay the expenses of such committees, even though they may not be considered its instrumentalities. When and how to exercise this power is left entirely to the Commission's discretion.

Former subsections (e), (f), and (g), which duplicate provisions elsewhere in the Compact, are omitted. Subsection (e), the general power to administer and enforce the Compact provisions, is not properly one of the auxiliary powers of the Commission, but is one of its purposes, as set forth in section 3.1. Subsection (f), on rule-making, and subsection (g), giving the power to issue subpoenas and administer oaths, are covered by section 5.2(a) and 4.4(b), respectively.

Subsection (e), formerly (h), is amended to reflect the decisions of the Supreme Court of the United States in Camara v. Municipal Court, 387 U.S. 523 (1967), and See v. City of Seattle, 387 U.S. 541 (1967), holding that administrative health and safety inspections are subject to the provision of the Fourth Amendment's prohibitions on unreasonable searches and seizures. These decisions now make it necessary for states generally to develop new procedures for constitutionally valid administrative inspections, either by authorizing the agencies to obtain the same type of search warrant available to police agencies, developing a special warrant for health and safety inspections, or some other means. Since the particular procedures will depend largely on the different court systems and other legal elements in each state, this section, like others in this draft dealing with procedural and judicial matters, makes the various State laws applicable to the Commission rather than developing a special system for its use. Each party state will shortly be faced with the need to provide a procedure--by new legislation or judicial construction of existing statutes--to make its air pollution control inspections consistent with the new decisions; these procedures will then be available to the Commission.

Subsections (g), giving the Commission the right of eminent domain, and (h), giving it the power to develop such physical facilities as may be needed, are new. Unlike most other regulatory functions, air pollution control (particularly regional air pollution control) may require the use of operating facilities such as air quality sampling stations, meteorological installations, communications facilities for emergency warnings and the like, and other systems. Some doubt might exist whether the grant of the ordinary powers to obtain and hold property (subsection (c) of this section) is broad enough to cover this type of activity, which is actually a form of operating authority rather than merely a housekeeping power incident to the Commission's substantive activities; and, of course, the power simply to acquire property does not confer the right to exercise the power of eminent domain. While the right to condemn property will probably be exercised sparingly if at all, it may in some cases be necessary and, as a basic power of sovereignty of the party States, the Commission can only obtain it by express grant. While the Commission would act in its own name in condemnation proceedings and not as an agent of the States, the proceedings are those followed by the respective States themselves, except insofar as State legislation may provide special powers or procedures for the Commission. While the Commission is empowered by these subsections to act itself to develop operating facilities, it may of course act through, or cooperatively with, other agencies under the provisions of this Compact providing for such co-operation.

Subsection (i) is new; it is a general provision, common in charters of public agencies that have an independent corporate existence, authorizing it to perform any other lawful actions not specifically defined where appropriate to its powers and duties. A provision of this type does not add to the substantive goals or purposes of the agency, or enlarge its right to govern; it simply provides that in connection with its lawful activities it is empowered to perform any acts which private individuals or corporations generally can perform. It is useful in order to ensure that an agency is not narrowly limited by a technical reading of the particular powers set forth in the act creating it.

§ 4.1: Subsection (d) of this section is new. It authorizes the Commission, when and if the developing technological and economic knowledge relating to air pollution makes it appropriate, to levy fees upon the emission of air contaminants. Such charges might, in addition to allocating some part of the costs of public air pollution control activities to those whose activities make the program necessary, provide a far more tangible economic incentive for minimizing emission of contaminants than any conventional penalty structure.

§ 4.2: Prior subsection (c), authorizing the Commission to exercise such emergency powers as the States may authorize, is replaced by a provision permitting the Commission itself to provide for sweeping modifications of its procedures, and the imposition of special requirements, during emergencies. Since the Commission would have the primary jurisdiction in air pollution control within the compact region, it should have the power to take emergency action as a part of its basic charter and not dependent on special grants from the states. Making any aspect of the authority to regulate (as distinct from such matters as court procedures and budgetary processes which must be fitted within existing structures in each state) subject to individual grants by states undercuts the ability to treat the region as a unit; the necessity for equivalent enforcement and regulation throughout the region was one of the main reasons for development of this Compact. Note that, in any event, the emergency provisions do not really enlarge the Commission's jurisdiction--that is, its general powers to regulate. They simply authorize, in an emergency, (1) the issuance of restrictions as drastic as may be necessary in the circumstances, and (2) the bypassing of normal procedures, such as advance notice and hearing or action by formal meeting of the Commission rather than orders by the responsible officers, that would delay or otherwise interfere with dealing with the emergency. Authority for summary action does not mean that the Commission is free of legal control. Emergency actions may be challenged in enforcement proceedings or other proper legal action, although of course courts will be much more reluctant to second-guess the action under such conditions. This subsection, it will be noted, contemplates that the Commission will provide in advance for procedures to be utilized in an emergency and the manner of determining the existence of such conditions and invoking the procedures; the particular rules to be issued for the emergency, however, may not be determinable in advance since each air pollution hazard situation may have special characteristics. The precise nature of the emergency powers and procedures is left entirely to the Commission's determination, within constitutional limitations; these matters require the technical judgment of a specialized agency as much as the development of substantive standards. Finally, the subsection authorizes cooperative planning for emergencies and, where appropriate, the exercise by one agency of the powers and functions of another. This could permit the Commission to exercise such elements of the general police power of the state that might arguably be beyond its scope under this Compact, where a state agency (such as a Board of Health) has such sweeping powers and is authorized to delegate them.

§ 4.3: This section is new and represents one important respect in which the Commission under this Compact would be stronger than the Mid-Atlantic Commission. Where section 2.8(a) of the prior compact prohibited the exercise by the Commission of any power of licensure except where specially permitted by action of the States, this section explicitly grants the power. This power is a basic element of the air pollution control process and an essential power of any agency that will itself be the primary body with air pollution control responsibility within its region, rather than an overall agency working largely through existing arms of government. The extreme importance of the power of licensure, particularly as standards incorporate design requirements rather than simply regulating emissions, requires that licensure be broadly authorized wherever the Commission deems it needed and that it be applied to existing installations as well as new construction. Provisions governing existing facilities may, of course, be less restrictive and take effect on a delayed basis.

While licensure transfers much of regulation from the enforcement process (after an alleged violation) to an administrative proceeding in advance, this need not unduly burden the Commission. It might, for example, delegate some aspects of the testing and inspection requirements to local agencies (either by requiring that permits be obtained from them or by accepting their certificate of compliance as a basis for a Commission permit) or to the regulated parties themselves (by accepting a certificate of compliance with the relevant rules from an engineer or other qualified person as a basis for issuing the permit).

Note that this section requires no special provisions dealing with enforcement. If the Commission's rules subject a certain type of facility to a permit requirement, then the operation of an unlicensed facility is a violation of its rules, making applicable the general enforcement provisions of the Compact, including the per diem civil penalty and the power to obtain injunctions.

§ 4.4: Two clarifying changes have been made, without altering the substance of this section. Reference to "such notice and hearing as may be required by due process of law" has been changed to "such notice and hearing as shall be provided for by its rules." The prior language had no effect in itself, since the Commission, as an instrumentality of government, is subject under the Constitution to the requirement of adherence to due process of law wherever applicable. The new language emphasized the Commission's power to regulate the manner of notice and hearing, and its duty to prescribe in advance orderly rules of procedure. Second, the language dealing with injunctions has been amended slightly to make clear what was probably implicit in the original wording, that the Commission may seek and obtain the three varieties of injunctive orders. These are temporary restraining orders, issued before any hearing where delay would cause irreparable harm; temporary injunctions, issued after preliminary hearings pending final disposition of the case; and permanent injunctions, which finally dispose of the case.

§ 4.7: This section, like its predecessor, provides that the individual States may regulate the proceedings for judicial review of Commission actions, subject of course to the provisions of the Compact. The second sentence, which is new, provides that in the absence of such provision, review will follow the provisions governing the air pollution control agency of the respective States; this clarifies the effect of the provision and eliminates any possible need for State law concurrent with compact enactment to make the State's general judicial review procedures applicable. Each of the three states does, in fact, make the standard provisions of law governing review applicable to its air pollution control agency. Thus, Delaware provides that determinations of its Water and Air Resources Commission may be appealed in court, subject to the ordinary rules of law and equity. Del. Code Ann., tit. 7, § 6012. New Jersey provides that orders of the Department of Health under its air pollution control provisions may be reviewed by "procedure in lieu of prerogative writs"; which replaces, in that State, the common law means of challenging administrative action. N.J. Rev. Stat. tit. 26, § 2C-20. Pennsylvania provides that its Air Pollution Commission is subject to its general administrative procedure law, including its provisions for judicial review. Penna. Stat. Ann. tit. 35, § 4005(e)(5), (g).

Subjecting determinations of the Commission to these differing review procedures and to the varying court rules and case law that relate to them, is a complicating factor, but an unavoidable result of the creation of an interstate body with powers affecting private interests. Review proceedings, even if some uniform rules were set out in the Compact, would have to operate in the settings of the differing court systems, procedures and practices of the three States. The only alternative would be to arbitrarily assign all such suits to one jurisdiction, presumably that in which the Commission's head office is housed. But this is probably not appropriate, since these proceedings relate not to general questions of the Commission's corporate existence or powers, but to specific findings and orders which will ordinarily apply to particular persons and property within one of the States. Leaving judicial review to the courts of the several States involved places it on the same footing as the reverse form of proceeding--action by the Commission to enforce the Compact or its rules or order--which of course is brought where the violation occurs.

§ 5.2: An exception to the requirement of subsection (a) for hearings on proposed rulemaking is provided for in the case of emergency rules, to reflect the authorization given in section 4.2(c) to issue such rules without prior hearing. See notes to section 4.2(c). The amendment here makes clear that section 4.2(c), and not this section, governs, despite the provision of the opening sentence of that section that emergency powers must be "not inconsistent with the provisions of this Compact."

§ 5.4: Subsection (c) is new. It provides for an annual report by the Commission to the States and the Federal government, such other publications as may be appropriate, and the general dissemination of public information. The subsection thus supplements the rest of the section, which makes Commission meetings and records open to the public, by imposing an affirmative duty of informing the public on the air pollution problem, Commission activities, and the public's powers and duties. The section makes clear that an extensive program of publications, and other public education activities is a proper use of Commission funds.

§ 5.7: The corresponding section in the Mid-Atlantic Compact makes the Commission liable for the acts and omissions of its employees "only to the extent and subject to the procedures prescribed by law generally with respect to officers, agents and employees of the government of the United States." Since this Commission is solely an instrumentality of the compacting States (see section 6.4) it seems more appropriate to state the governing standard directly rather than by reference to a body of law no longer relevant to its activities. The effect of this section is substantially similar to that of its predecessor, since the language added is modeled on that of the Federal Tort Claims Act, 28 U.S.C. §§ 1346(b), 2671-80. That Act makes the Federal government liable as a private party, subject to a number of exceptions. The two most basic and relevant questions are those stated here--matters arising out of discretionary acts, and acts authorized by law or rule, whether or not valid. This in effect preserves the power of an agency of government to govern, and ensures that tort actions are not used as a means of challenging exercises of executive or legislative power. Although a basic uniform rule of liability is laid down by this section, actions against the Commission under it will, of course, be governed by the general rules and procedures for suit for damages in the courts of the respective States.

§ 6.1: This section is amended to provide for the assumption of the expenses of the Commission by the party States rather than by the States and the Federal government, since the Commission is now solely an instrumentality of the States instead of a Federal-State body. Federal contributions to air quality control in the Penjerdel Region will take the form of grants under Federal law (see sections 105 and 106 of the Air Quality Act) rather than an obligation under the Compact. This accords with the changed nature of the Commission and with the position of the Department of Health, Education and Welfare. See 1968 Compact Hearings, p. 466.

The apportionment formula is here stated in the Compact rather than being left to the Commission's determination. State contributions are to be apportioned in proportion to the equalized value of taxable real property (the basic element of a local tax base) within each State's portion of the Region. The States may, in turn, impose the financial burden on the local governments within their respective parts of the Region. Although the costs of the operations of the Commission, as a unit of regional government, may thus ultimately be charged against the area of its jurisdiction, the States, as the parties to this Compact, remain obligated in the first instance to pay the sums required by the Commission to balance its budget and ensure its continued operation.

§ 6.4: This section is derived from section 6.4 of the New York version of the Mid-Atlantic Compact, which was not included in the Compact as enacted by the other states and was repealed by N.Y. Laws 1968, ch. 385. That section made the commission "subject to or exempt from Federal statutes generally applicable to an agency and instrumentality of the Federal government as may be provided by Federal law." It is amended to reflect the fact that the Commission established by this Compact is solely an instrumentality of the party States, see sections 2.2-2.4 and notes thereto, and therefore is not to be deemed an agency of the United States merely because the United States has a representative on the Compact Commission. The Department of Health, Education and Welfare has recommended such a provision. 1968 Compact Hearings, p. 466. Note, however, that the language of the section leaves open the possibility that at some future time Congress might wish to confer upon the Commission—or upon compact agencies performing functions under the Air Quality Act generally—such of the privileges and immunities of Federal agencies as it may deem appropriate.